Electronics Today

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July 1987

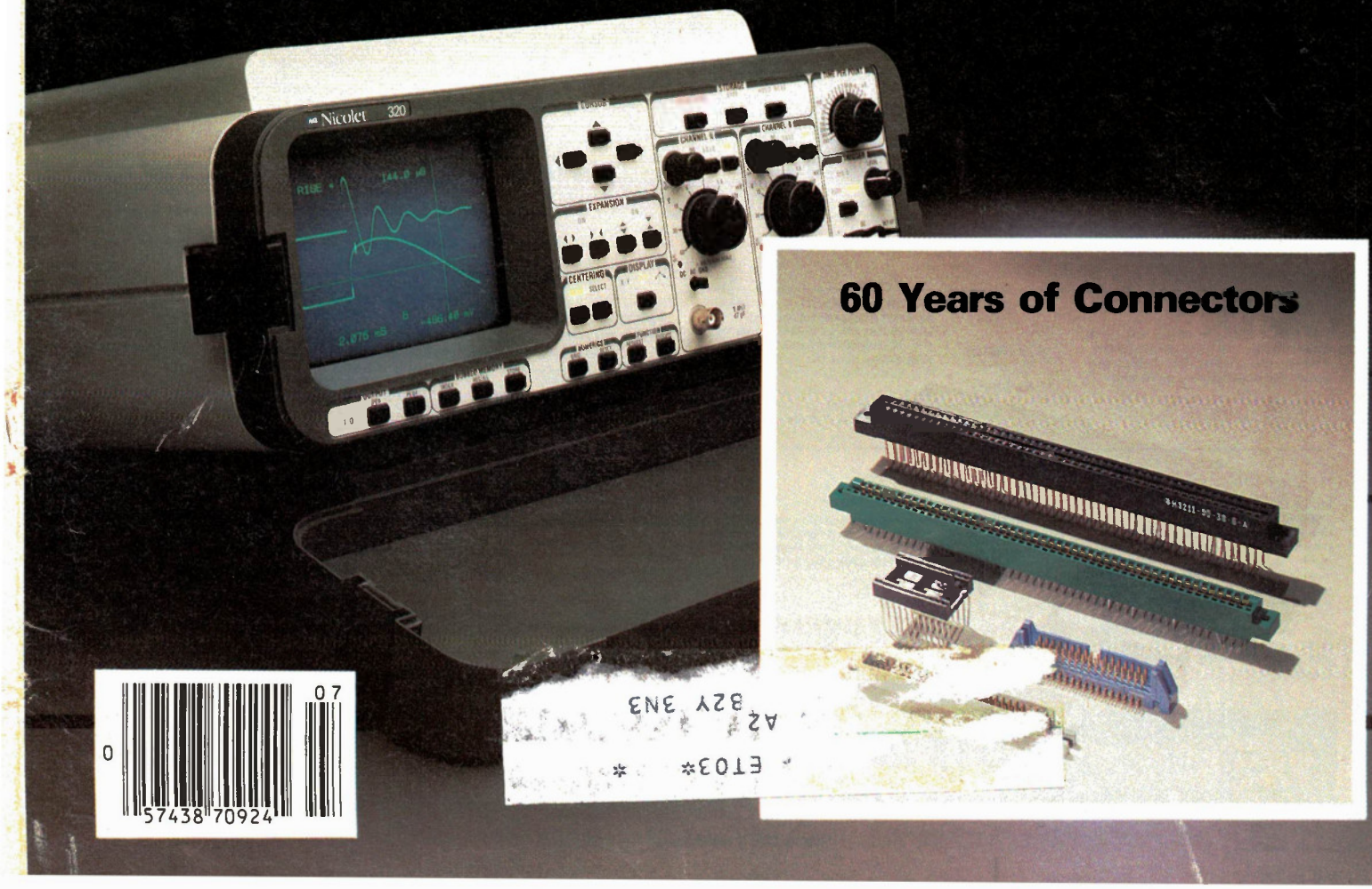
Canada's Magazine for Electronics & Computing Enthusiasts

Test Equipment Special!

What's new for the testbench

Automotive Timer Project

Waveform Simulation on the PC



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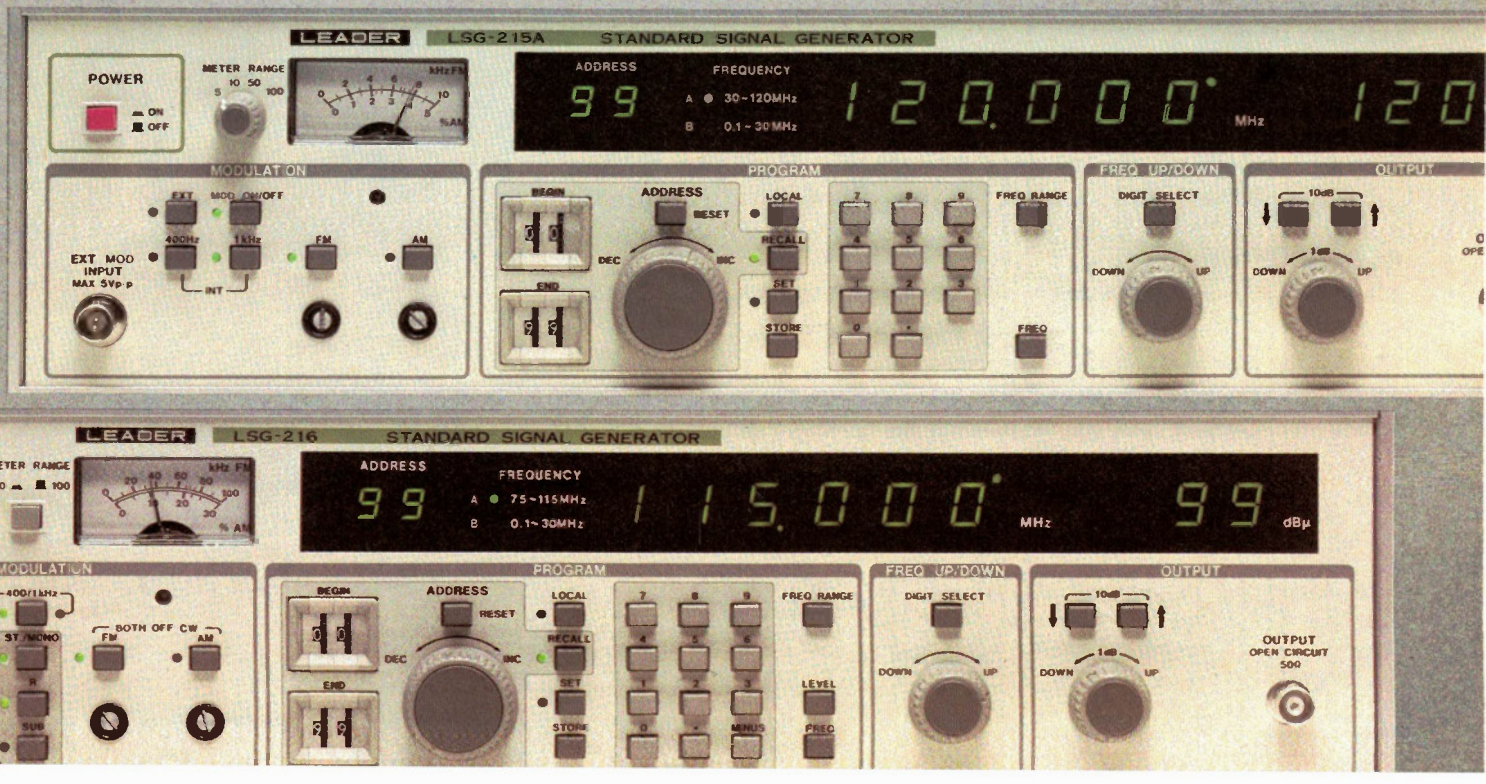

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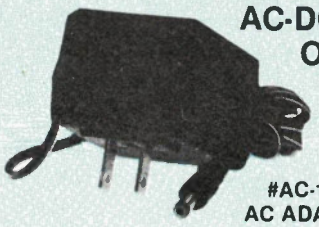

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July 1987 **Vol. 11 No. 7**

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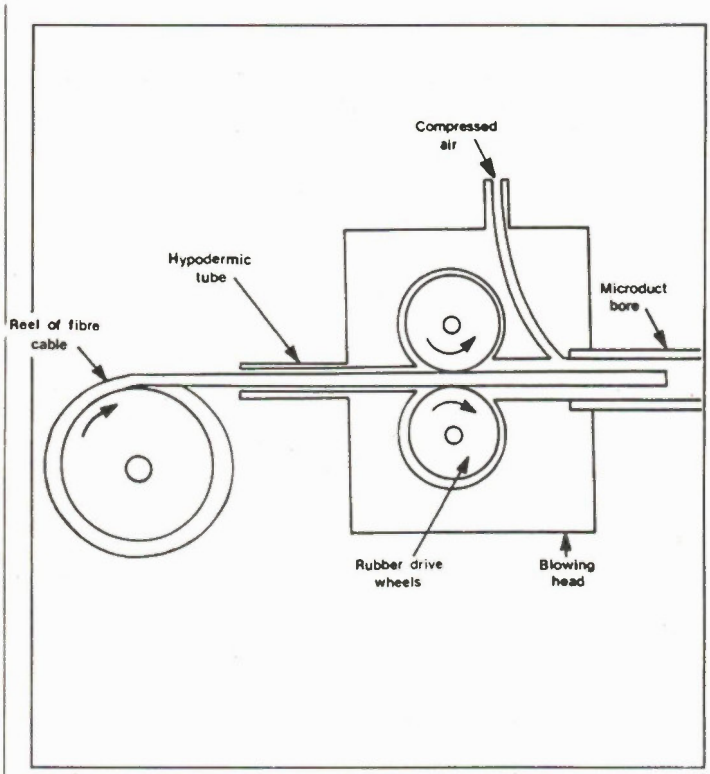

The blowing head, showing the working principles of the blown fibre system.

Cables Blown Into Ducts By Air Pressure

by Bruce Wiltshire

A new system that will radically change the way cables are installed has been devised by British Telecom. Called blown fibre, it enables optical communications cables to be installed quickly and efficiently in the local network. Miniature optical cables are blown by compressed air into small tubes already pre- installed in the ground and within buildings. The system has tremendous potential. It can be used for the complete range of local area applications - linking one building to another, or linking buildings back to the local exchange. It can also be used extensively within buildings themselves, to provide fibre optic local area networks.

The blown fibre system was invented at British Telecom Research Laboratories (BTRL) at Martlesham Heath, eastern England, some years ago. Since then the technique has been refined and in 1984, working field trials were set up at many sites around the United Kingdom. These trial systems have since operated successfully.

The equipment that makes up the blown fibre installation system consists of three parts: microducts, optical cable, and blowing equipment.

Can Take Bends

The topography of a typical local network is such that it will be necessary to blow cable around tight bends without damaging the fibres in the cable. Minimum bend criteria have long been of concern to optical cable designers. However, blown fibre cable is designed to negotiate bends of less than 20 mm radius, with little strain being induced into the fibres. This makes it possible to blow into long, complicated routes containing many bends with little risk of fibre damage.

Once the cable is installed, there is minimal residual strain left in the fibres. This alone leads to one of the major economic advantages of the blown fibre concept; the lack of any need to pressurize the network to keep moisture out. The entire cable system can withstand total immersion in water and normal duct pollutants.

The blown fibre technique is to be used extensively throughout the British Telecom local network, for the installation of optical fibre.

Links Optional

A 28mm diameter microduct, containing seven 6 mm bore polyethylene tubes, forms the main artery of the external blown fibre network. Microducts are installed empty in normal service ducts just below ground level, and they can be laid using conventional pulling methods, with no special precautions. A twin tube microduct sheathed in fire retardant PVC is also available for use within buildings.

Once the microducts are installed, the 6 mm bore tubes can be connected together in any desired combination with simple press- on connectors. In this way continuous dedicated tube paths can be routed from one part of the work to another. Standard polyethylene material is used in the manufacture of the microduct bore. Chemical additives ensure that the surface friction coefficient inside the bore is of a low value to allow the fibre cable to be blown through. This effect persists over long periods, so that empty bores can be blown through in ten or even 20 years time.

The second part of the blown fibre installation system is the optical cable itself. At only 2 mm in diameter, it contains a package of standard singlemode or multimode optical fibres. Two cable sizes are available, a four fibre and a seven fibre.

Materials Research

The cable construction is such that the individually coloured fibres are packaged together and sheathed in an expanded foam coat. This cable design, containing no metal parts or strength members, gives the optical cable its light weight, makes it possible to handle, and most importantly, provides sufficient surface area so that it can be blown through the microducts.

Prototype optical cable manufacture was carried out originally at BTRL, where much research and development went into defining the optimum coating materials and precise cable manufacturing parameters. This ensured, first, that the cable had the necessary mechanical properties to withstand the blowing operation and, secondly, that once installed, it had good optical transmission properties over the temperature range from -10 to +40 degrees C.

The final part of the blown fibre installation system is the blowing head. In a typical network, this can be used to install at least 500 m of fibre cable in a single operation, with longer lengths possible by cable rewinding techniques.

Engineering

Engineering as a profession is largely a milestone of the 20th century, even though engineering as an activity has been practised since antiquity. Here in Canada, the 1871 census reports that there were 70 individuals who listed their occupation as engineer. Today, there are over 130,000 registered professional engineers. They are well integrated within the national economy; some 50 per cent work in industry, 20 per cent provide consulting services, 20 per cent are in the public sector, and the remaining 10 per cent are engaged in all walks of life. Some are also medical doctors, members of the clergy, accountants, and members of provincial legislatures or the federal Parliament.

While the nature of the engineering work tends to be quite diverse, 25 per cent of registered professional engineers are managers, 45 per cent supervise the production of material goods, 10 per cent are involved in research and development activities, and the balance have careers in many areas, including teaching, marketing and other activities.

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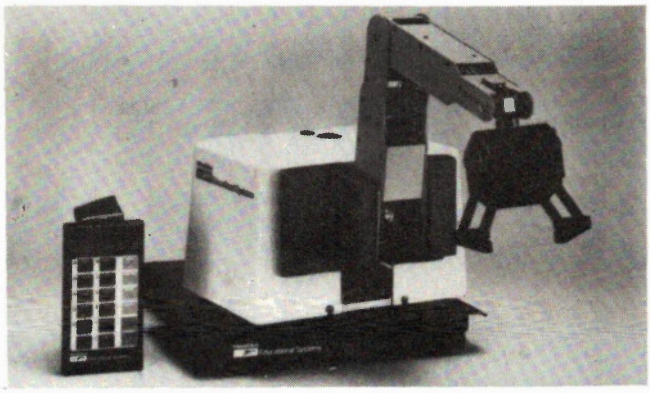

Radon Meter

With the help of a new, portable radon meter it is easy to measure the amount of radioactive radon gas in apartments, homes and other places where people spend a great deal of their time. The meter, which is called IlmaRadon, has been developed by Ilmasti Oy in Finland. Radioactive radon gas is found naturally in the earth's crust and can work its way into buildings through cracks in foundations, bad joints or porous materials. The gas can also be found in construction materials or in tap water. In large quantities radon is a health hazard.

The new radon meter is based on the idea that the concentration of ions in the air of a room is proportional to the concentration of radon. The measurement results are promptly presented in Bq/m^3 (Becquerels) with continuous readings in the optional measurement areas from 0 to 10,000 Bq/m^3. The quickest measurement is performed by carrying the IlmaRadon meter around in a particular room; it reacts to different levels of concentrations in just a few seconds. The unit can also be used for continuous weekly registration of information.

The level of radon can vary substantially within different parts of a building; in some areas the amount of radon can be up to 50 times higher than in others. One of the advantages of the IlmaRadon is that, according to the manufacturer, it makes it easy to determine where the gas is entering the building and where the largest concentration is.

Circle No. 27 on Reader Service Card

Can/Japan Semiconductors

MOSAID Technologies Incorporated, of Kanata, Ontario, an independent memory chip design and consulting house, has recently announced the signing of a technology transfer agreement with a leading Japanese semiconductor company.

The agreement, valued at over $1 million CDN for the initial phase, calls for the transfer of engineering designs of memory chips, specifically two families of Dynamic Random Access Memory (DRAM) integrated circuits. MOSAID will also provide engineering support for the DRAM chips.

The transfer of technology will be complete by the fall of 1987, with the Japanese manufacturer beginning full-scale production of the chips before the end of the year. Royalties on the sale of the integrated circuits in the present agreement and future design developments are expected to more than double the total value of the agreement within three years.

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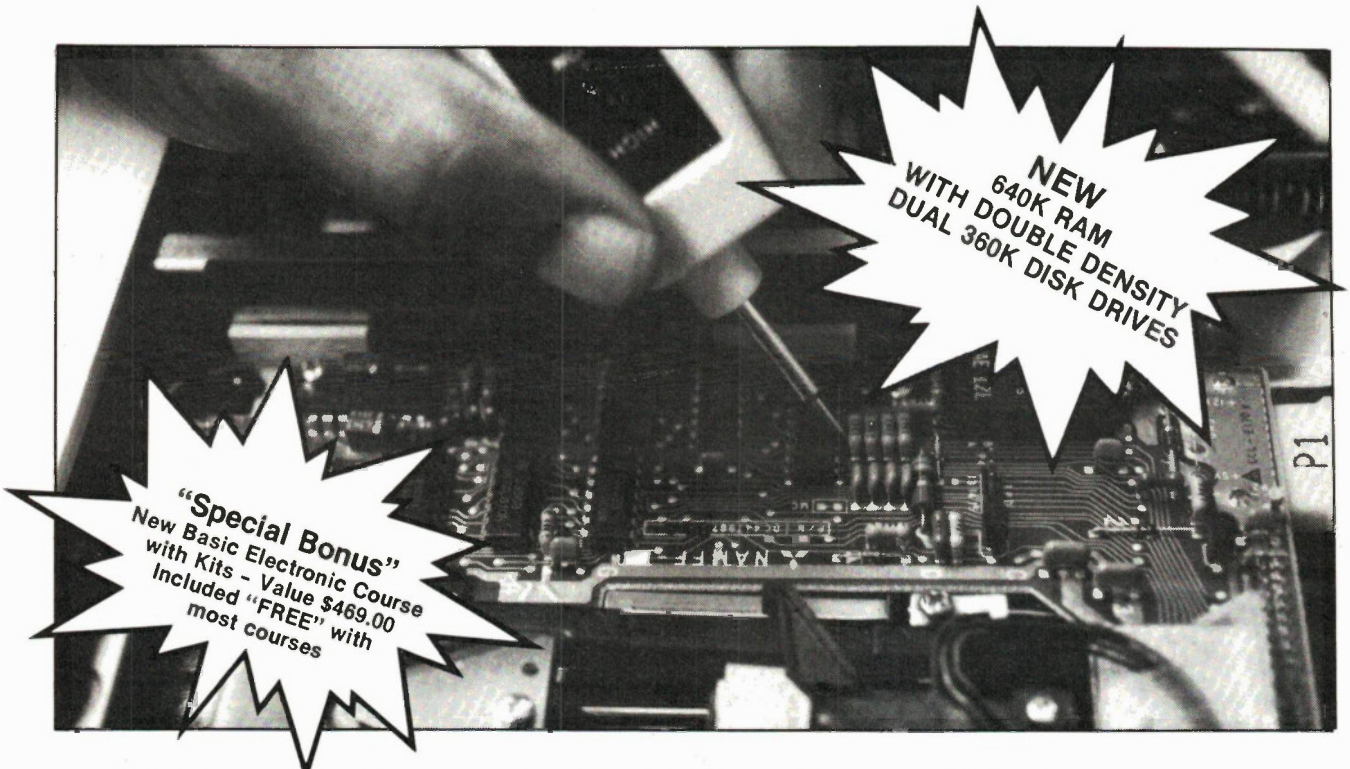

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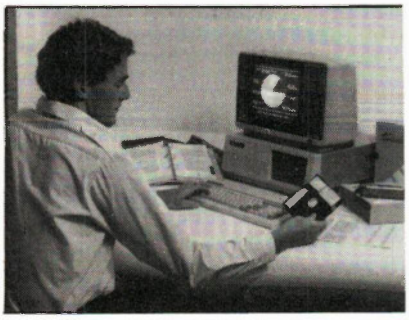

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Automotive Timer

A handy automotive timer with a multitude of applications.

By D. Butler

The Automotive Timer project was originally designed as a "choke-on" reminder for cars with manual chokes. However, other applications can easily be found, as the circuit is a timer with an alarm. The timer is fully adjustable, as is the alarm note, it consumes little power and occupies a modest amount of space.

Circuit Description

The timer is formed around IC1 (Fig.1), a 4060 14 stage ripple counter and oscillator. Components R1, R2, and C1 set the oscillator frequency, hence the timing period. The reset pin (pin 12) is provided with a pulse every time the supply is connected by the action of C2 and R3. In this way the timer is always initiated at the same point. The timer is activated by applying +12V to the supply line. Particular ways of achieving this will be considered later. The actual timing period is adjusted by connecting an oscillator output to the alarm circuit described below.

Piezo Alarm Circuit

The alarm circuit produces a twin tone which may be modified by changing components C3, R5 and C4, R6. The transducer (WD1) is a ceramic piezo-electric element which generates tones when a 3V peak square wave is applied. Rigid mounting methods ensure maximum volume levels, which is necessary in the environment of a car. The element has no moving parts, is robust and consumes little power.

A final mention should be made of diode D1, which protects the circuit from reversal of power connections.

Applications

As mentioned earlier, the project was originally designed as a "choke-on" reminder and, therefore, the unit needs to be activated when the choke control is used. Obviously it is not possible to give detailed switching methods used on every type of car, but Figs. 2 to 4 illustrate several alternatives.

The timer may be activated easily if the choke control already has a switch included, usually for a dashboard warning lamp. In many cases this switch is connected to ground which means that the timer +12V should be permanently joined to +12V via the ignition. Using the choke cable is slightly more difficult, and sections (1) and (2) show switching methods.

(1) Shows the choke cam plate on the side of the carb. A miniature micro switch is mounted where indicated by "*". The normally closed contacts are used as the microswitch lever will be released as the choke is turned on.

(2) Shows the choke cable near the control knob. A bracket (X) is attached to the control knob mounting thread, on which is a reed switch (Y). This is connected to +12V via ignition, and the +12V switched line of the timer. A small magnet is attached to the cable using twisted wire and insulation tape. The distance from the reed switch is judged by pulling the choke out and seeing whether the reed switch has engaged. Push the control back in and check that the switch has turned off. You may be surprised how far the magnet has to be fastened from the reed, as they are very sensitive. The reed and magnet method may be employed at either the control knob or carb end.

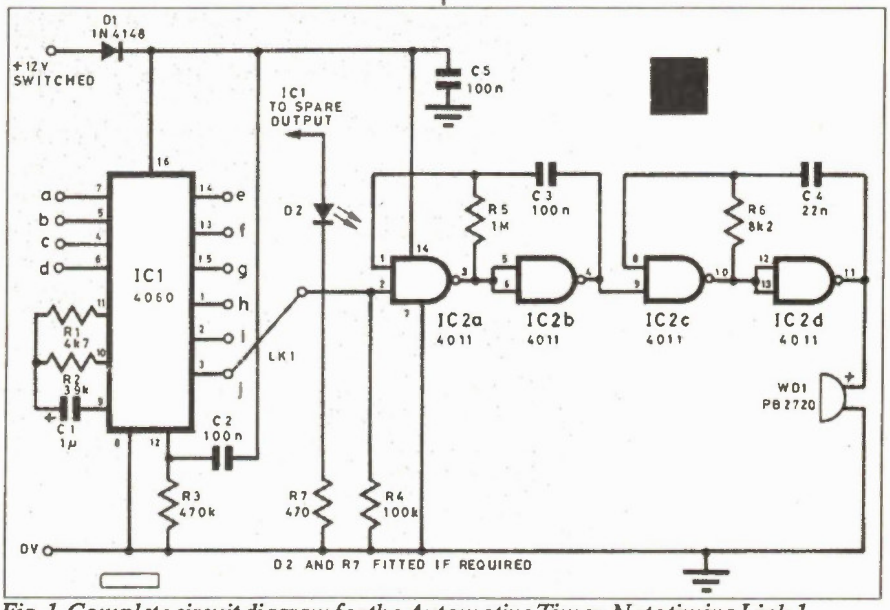

Fig. 1. Complete circuit diagram for the Automotive Timer. Note timing Link 1.

Table 1

Connect LK1 to:	Approx. time
a	½ sec
b	1 sec
c	2 sec
d	4 sec
e	8 sec
f	18 sec
g	36 sec
h	2 min 23 sec
i	4 min 45 sec
j	9 min 30 sec

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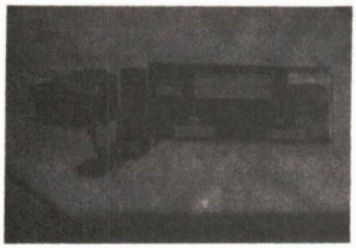

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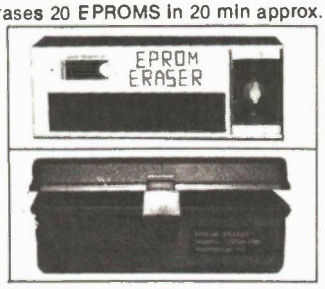

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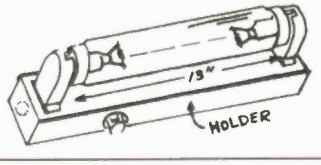

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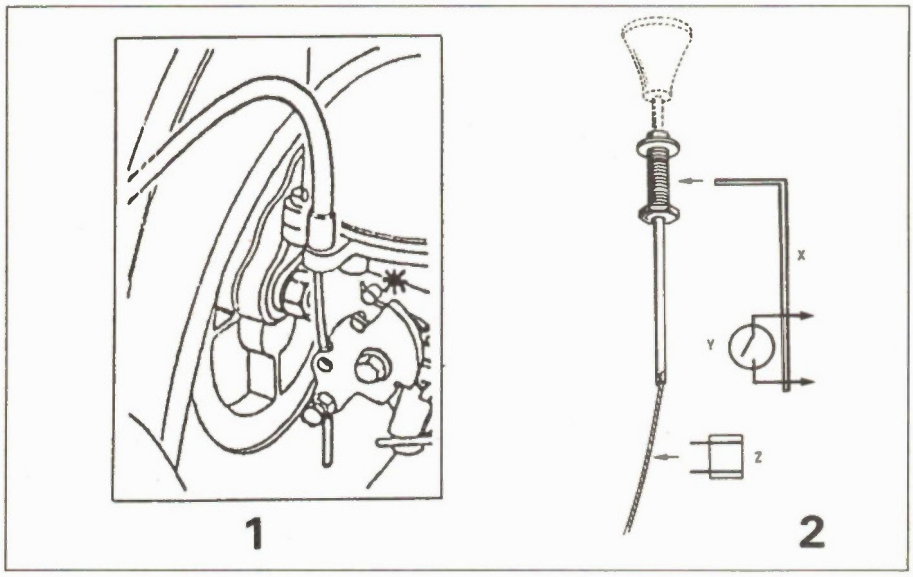

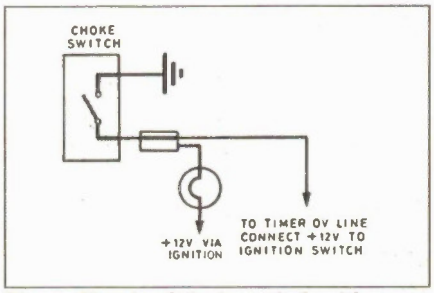

Fig. 4. Circuit of choke switch with warning light. The mechanical arrangement is shown left: 1 using a microswitch and 2 using a reed relay with magnet

R1 = 4k7
R2 = 39k
C1 = 1u
Supply Voltage = 12

Fig. 2 also shows how the timer may be used on the rear window defroster. If the alarm goes off and the defroster is still needed, just turn the switch off and then back on. The alarm will be cancelled for another time period. Fig. 3 shows its use as a parking meter timer.

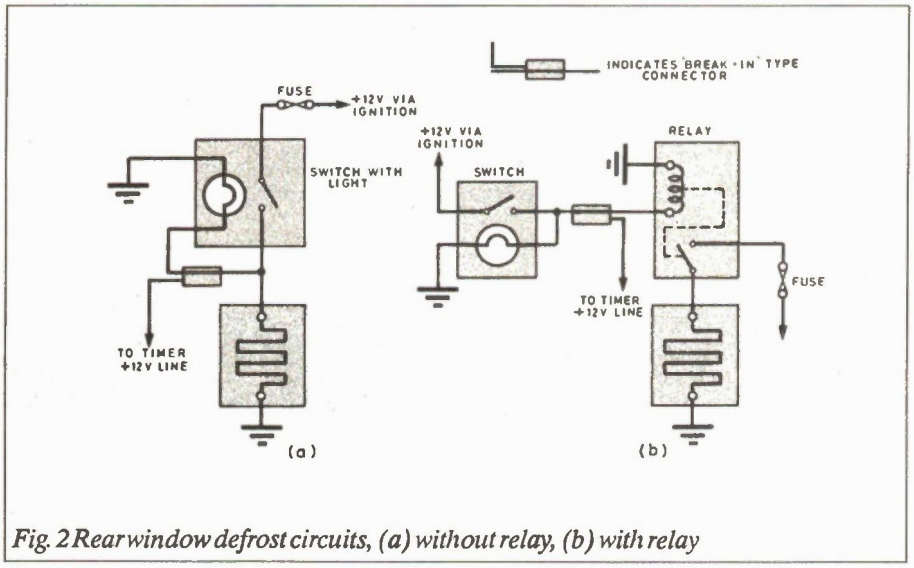

Fig. 2 Rear window defrost circuits, (a) without relay, (b) with relay

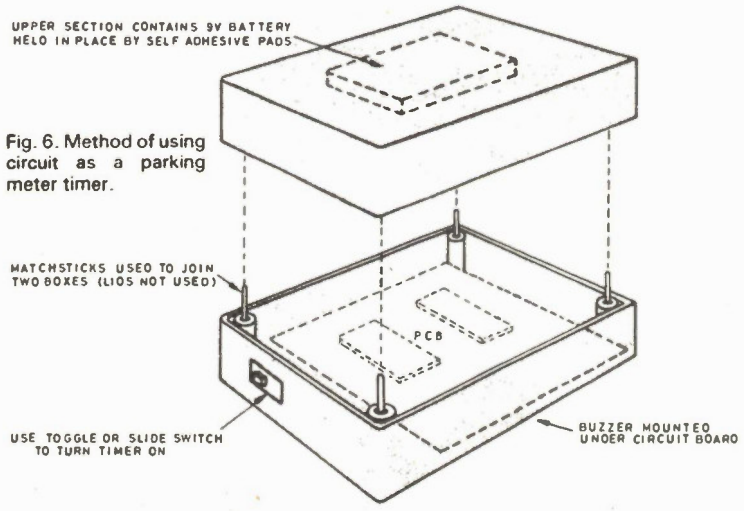

Fig. 6. Method of using circuit as a parking meter timer.

Fig. 3. Method of using circuit as a portable parking meter timer.

Parts List

Resistors

1/4W, +/-5% carbon types

R1	4k7
R2	39k
R3	470k
R4	100k
R5	1M
R6	8k2
R7	470R (if required)

Capacitors

C1	1u 16V tant. bead
C2	100n polyester
C3	100n min. layer polyester
C4	22n min. layer polyester
C5	100n polyester

Semiconductors

IC1	4060 ripple counter and osc.
IC2	4011 dual input NAND gates
D1	1N4148 diode
D2	LED with mounting clip
WD1	Piezo transducer, 12V

Miscellaneous

PCB or Veroboard; case to suit (if required); mounting hardware; spade connectors; switch to activate timer, e.g. microswitch, mercury tilt, pushbutton (see text).

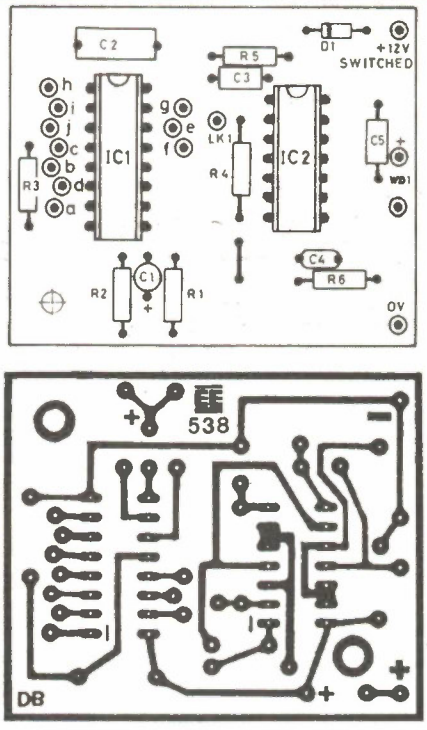

Fig. 5. Component layout and printed circuit master (full size). Note a link wire should be attached to L:K1 and one of the timing pins.

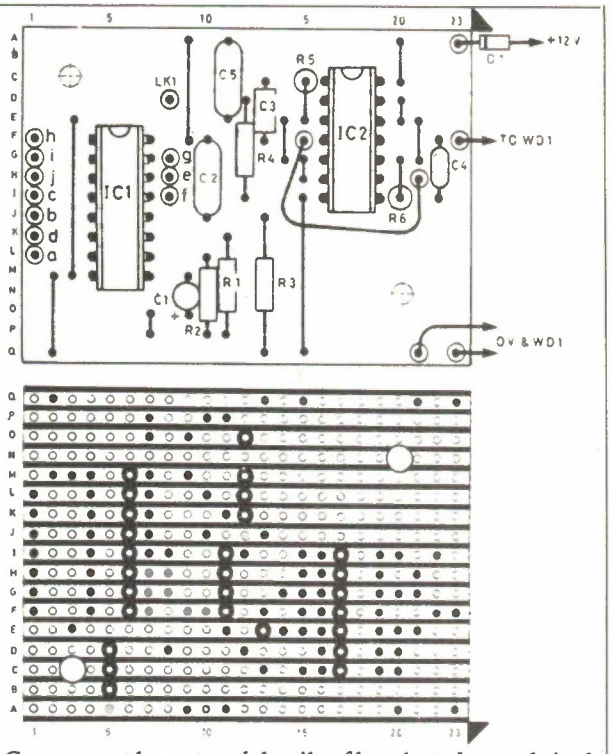

Fig. 6. Component layout and details of breaks to be made in the underside copper strips of the stripboard version

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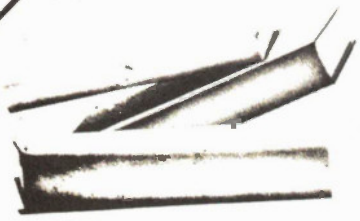

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There is now a vast range of ICs available to the amateur market, the majority of which are not necessarily designed for use in a single application and can offer unlimited possibilities. All the projects contained in this book are simple to construct and are based on a single IC. A few projects employ one or two transistors in addition to an IC but in most cases the IC is the only active device used.

223: 50 PROJECTS USING IC CA3130 $5.00
R.A.PENFOLD
In this book, the author has designed and developed a number of interesting and useful projects which are divided into five general categories: I — Audio Projects II — R.F. Projects III — Test Equipment IV — Household Projects V — Miscellaneous Projects.

BP118: PRACTICAL ELECTRONIC BUILDING BLOCKS - Book 2
R.A. PENFOLD $7.60
This sequel to BP117 is written to help the reader create and experiment with his own circuits by combining standard type circuit building blocks. Circuits concerned with generating signals were covered in Book 1, this one deals with processing signals. Amplifiers and filters account for most of the book but comparators, Schmitt triggers and other circuits are covered.

BP83: VMOS PROJECTS $7.80
R.A. PENFOLD
Although modern bipolar power transistors give excellent results in a wide range of applications, they are not without their drawbacks or limitations. This book will primarily be concerned with VMOS power FETs although power MOSFETs will be dealt with in the chapter on audio circuits. A number of varied and interesting projects are covered under the main headings of: Audio Circuits, Sound Generator Circuits, DC Control Circuits and Signal Control Circuits.

RADIO AND COMMUNICATIONS

BP177: AN INTRODUCTION TO COMPUTER COMMUNICATIONS $7.80
Connecting up an ordinary home computer to the telephone system via a modem opens up a new world of possibilities: talking to other computers, databases, networks, radio links, etc. An explanation of basic principles and practicalities in simple terms.

BP176: A TV-DXERS HANDBOOK $18.00
This book will be a practical guide for the beginner and a source of reference for the established TV-DXing enthusiast. The possibilities and problems of receiving television signals over long distances and resolving of such pictures with the minimum of distortion is discussed. Also included are many units and devices which have been designed by experienced enthusiasts.

PC Simulations

Explore digital simulations on your PC.

by Joseph and Robin Berardi

Some computer companies may lead you to believe that simulators are complicated and require main frame power, but just about any present day personal computer can perform digital simulations. Our simulator program is written in GWBASIC and can be run on most MS-DOS-based home computers. It will allow you to see your output waveforms right before your eyes on your own computer monitor. The purpose of this program is to introduce you to a digital simulator that is very simple yet expendable.

Digital Design Fundamentals

Let's make a brief review of the principals of binary logic design as it applies to this simulator. A binary logic function has two possible logic states. These two logic states can be considered as the "on" and "off" states. Usually a "0" represents the "off" state and is known as a logic LO, while a "1" represents a logic HI or the "on" state.

These logic states, in terms of actual hardware such as the TTL logic family, represent a voltage level. Different logic families usually have different voltage levels but they all have three things in common, defined logic HI and LO voltage levels and an undefined state which lies between these two levels. See Fig. 1.

The transition from one logic state to another takes a finite amount of time in actual hardware. This is called the rise and fall time. There is also a propagation time that is associated with each device. This propagation time is the time it takes the signal to flow through the device and start switching the output. This simulator assumes there is a zero rise and fall time and only a one unit time delay from the input to the output of the devices supported. This one unit time delay is long enough to demonstrate how the propagation time can create unwanted glitches in poorly designed circuits.

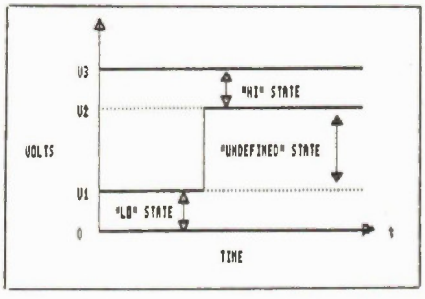


Fig. 1. The three logic states: high, low and undefined. V3 usually represents the power supply voltage.

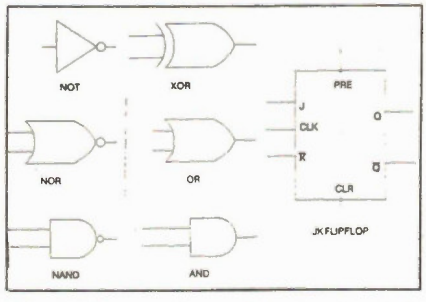


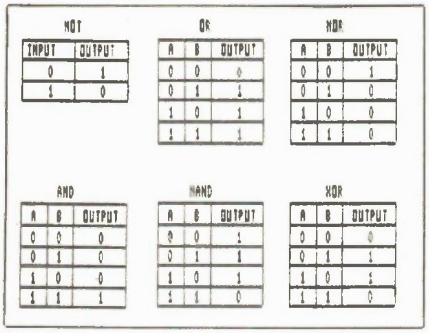
Fig. 2. Schematic symbols for the logic gates and the JK flipflop.

Binary Logic Symbols and Terminology

Logic gates are the building blocks of all digital designs. Even the most sophisticated circuitry in the world is no more than a group of logic gates used to design a digital circuit. This simulator has a simulation model for the following gates: AND, NAND, OR, NOR, NOT and XOR. It also supports a functional model of a JK Flip-Flop. Flip-Flops are the building blocks for counters and shift registers, and are essential memory elements for most sequential circuits. The symbols for these gates and the JK Flip-Flop are shown in Fig.2.

Truth Tables

Truth tables list the functional characteristics of a logic gate or circuit. These lists show the output logic state for every possible input logic state. Truth tables for the simulator models are shown in Fig. 3 and in Fig. 3B. A truth table can easily list all of the possible logic states for a single gate or simple devices but they are not practical for use with more complicated circuits. State diagrams have been developed for that purpose, and are too complex



NOT

INPUT	OUTPUT
0	1
1	0

OR

A	B	OUTPUT
0	0	0
0	1	1
1	0	1
1	1	1

NOR

A	B	OUTPUT
0	0	1
0	1	0
1	0	0
1	1	0

AND

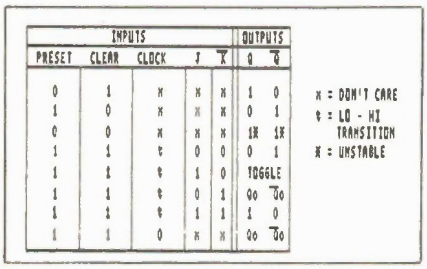
A	B	OUTPUT
0	0	0
0	1	0
1	0	0
1	1	1

NAND

A	B	OUTPUT
0	0	1
0	1	1
1	0	1
1	1	0

XOR

A	B	OUTPUT
0	0	0
0	1	1
1	0	1
1	1	0



INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	$\overline{K}$	Q	$\overline{Q}$
0	1	X	X	X	1	0
1	0	X	X	X	0	1
0	0	X	X	X	1R	1R
1	1	↕	0	0	0	1
1	1	↕	1	0	TOGGLE	
1	1	↕	0	1	Q_0	$\overline{Q}_0$
1	1	↕	1	1	1	0
1	1	0	X	X	Q_0	$\overline{Q}_0$

X : DON'T CARE
↕ : LO - HI TRANSITION
R : UNSTABLE

Fig. 3. (a) truth tables for the logic gates, and (b) the truth table for the 74109 JK flipflop.

to be discussed in an introductory article.

Creating a Circuit for Simulation

In order to create a simultable circuit, you must describe your circuit to the computer using the logic gates and Flip-Flop that the simulator supports and list how they are interconnected.

First, draw a schematic showing your circuit. Assign a node number to each input, output and internal signal in that circuit, and make a Net-List using this information. All of the three terminal gates use the following order for their nodes: INPUT, INPUT, OUTPUT. The NOT gate is a two terminal gate which uses the order INPUT, OUTPUT. The JK-FF order is: PRESET, CLEAR, J, NK, CLK, Q, NQ. The program will read the node numbers in the DATA statement and associate each number with one of the INPUT/OUTPUTS for that device. Look at line 10010 in the code printout. It reads 10010 DATA NAND,4,3,5. Node number 4 will be assigned to the first input and node number 3 will be assigned to the second input, while node number 5 will be assigned to the output.

Type your Net-List into the computer using DATA statements as shown in the program code printout starting on line 10005. The simulator

```
100 REM MINISIM MINSIM15
105 REM JOSEPH BERARDI
110 REM 9/6/86
500 REM INITIALIZE ************************************************************
502 SI=1:MI=1:TI=1
503 TRACES=10
510 DIM STATE$(100),NEXTS$(100),MODELS$(100),N(100)
520 DIM TIME(100),VALUE$(100),NODE(100)
530 TIMEINCREMENT=1
540 SIMTIME=0
550 FOR I = 1 TO 100
560 STATE$(I)="0"
565 MODELS$(I)=""
570 NEXT I
1000 REM LOAD STATE/NEXTS/MODELS ARRAY ***********************************
1010 READ A$
1020 WHILE A$ <> "END"
1030 IF A$="AND" THEN X=3:GOSUB 3000
1040 IF A$="NAND" THEN X=3:GOSUB 3000
1060 IF A$="OR" THEN X=3:GOSUB 3000
1080 IF A$="NOR" THEN X=3:GOSUB 3000
1090 IF A$="XOR" THEN X=3:GOSUB 3000
1100 IF A$="NOT" OR A$="INVERTER" THEN X=2: GOSUB 3000
1110 IF A$="JKFF" THEN X=7 : GOSUB 3000
1280 MI=MI+1
1290 READ A$
1300 WEND
1310 LASTSTATE=SI-1 : LASTMODEL=MI-1
1490 REM LOAD TIME ARRAY *************************************************
1500 READ A$
1510 WHILE A$ <> "END"
1530 TIME(TI)=VAL(A$)
1535 READ A$
1540 VALUE$(TI)=A$
1545 READ A$
1547 NODE(TI)=VAL(A$)
1550 TI=TI+1
1890 READ A$
1900 WEND
1910 LASTTIME=TI-1
2000 GOTO 4000
3000 REM X INPUTS ************************************************************
3010 MODELS$(MI)=A$
3020 FOR I = 1 TO X
3030 READ A$
3035 N(SI)=VAL(A$)
3040 SI=SI+1
3050 NEXT I
3070 RETURN
4000 REM SIMULATE ************************************************************
4020 REM INITGRAPHIC
4030 GOSUB 4700
4040 FOR I = 1 TO LASTSTATE
4050 NEXTS$(N(I))=STATE$(N(I))
4060 NEXT I
4100 WHILE SIMTIME < TIME (LASTTIME)
4110 SI=1
4120 FOR I = 1 TO LASTTIME
4130 IF ABS (SIMTIME-TIME(I)) < (.9 * TIMEINCREMENT) THEN NEXTS$(NODE(I))=VALUE$
(I)
4140 NEXT I
4200 FOR MI = 1 TO LASTMODEL
4250 IF MODELS$(MI)="AND" THEN GOSUB 5000
4270 IF MODELS$(MI)="NAND" THEN GOSUB 5100
4280 IF MODELS$(MI)="OR" THEN GOSUB 5200
4290 IF MODELS$(MI)="NOR" THEN GOSUB 5300
4300 IF MODELS$(MI)="XOR" THEN GOSUB 5400
4310 IF MODELS$(MI)="NOT" THEN GOSUB 5500
4320 IF MODELS$(MI)="JKFF" THEN GOSUB 5700
4390 NEXT MI
4400 FOR I = 1 TO LASTSTATE
4410 STATE$(N(I))=NEXTS$(N(I))
4420 NEXT I
4480 REM GRAPH IT
4485 GOSUB 4800
4500 SIMTIME=SIMTIME+TIMEINCREMENT
4600 WEND
4610 LOCATE 22,1
4690 END
4700 REM INITGRAPHICS ********************************************************
4702 REM SCREEN 1 = MEDIUM RESOLUTION WITH COLOR
4704 REM SCREEN 2 = HIGH RESOLUTION WITHOUT COLOR
4710 SCREEN 1
4712 COLOR 1,7
4714 CLS
4720 XCORD=25
4721 PRINT"     MINISIM"
4724 LOCATE 3,1
4725 FOR I = 1 TO TRACES
4727 PRINT I ;PRINT
4728 NEXT I
4730 RETURN
4800 REM GRAPH IT ************************************************************
4805 XCORD=XCORD+1
4810 FOR I = 1 TO TRACES
4850 YCORD=(16*I)+5-(4*VAL(STATE$(I)))
4870 PSET (XCORD,YCORD)
4890 NEXT I
4900 RETURN
5000 REM AND2 ****************************************************************
```

```
5010 NEXTS$(N(SI+2))="0"
5020 IF (STATE$(N(SI))="1") AND (STATE$(N(SI+1))="1") THEN NEXTS$(N(SI+2))="1"
5080 SI=SI+3
5090 RETURN
5100 REM NAND2 ************************************************************
5110 NEXTS$(N(SI+2))="1"
5120 IF (STATE$(N(SI))="1") AND (STATE$(N(SI+1))="1") THEN NEXTS$(N(SI+2))="0"
5130 SI=SI+3
5140 RETURN
5200 REM OR2 ************************************************************
5210 NEXTS$(N(SI+2))="0"
5220 IF (STATE$(N(SI))="1") OR (STATE$(N(SI+1))="1") THEN NEXTS$(N(SI+2))="1"
5230 SI=SI+3
5240 RETURN
5300 REM NOR2 ************************************************************
5310 NEXTS$(N(SI+2))="1"
5320 IF (STATE$(N(SI))="1") OR (STATE$(N(SI+1))="1") THEN NEXTS$(N(SI+2))="0"
5330 SI=SI+3
5340 RETURN
5400 REM EXOR2 ************************************************************
5410 NEXTS$(N(SI+2))="0"
5420 IF (STATE$(N(SI))="1") OR (STATE$(N(SI+1))="1") THEN NEXTS$(N(SI+2))="1"
5425 IF (STATE$(N(SI))="1") AND (STATE$(N(SI+1))="1") THEN NEXTS$(N(SI+2))="0"
5430 SI=SI+3
5440 RETURN
5500 REM NOT ************************************************************
5510 IF STATE$(N(SI))="1" THEN NEXTS$(N(SI+1))="0" ELSE NEXTS$(N(SI+1))="1"
5515 SI=SI+2
5520 RETURN
5700 REM JK-FF (74109) ************************************************************
5705 REM NP NC J NK CK Q ND
5710 IF (STATE$(N(SI))="0" AND STATE$(N(SI+1))="1") THEN NEXTS$(N(SI+5))="1" : N
EXTS$(N(SI+6))="0"
5720 IF (STATE$(N(SI))="1" AND STATE$(N(SI+1))="0") THEN NEXTS$(N(SI+5))="0" : N
EXTS$(N(SI+6))="1"
5730 IF (STATE$(N(SI))="0" AND STATE$(N(SI+1))="0") THEN NEXTS$(N(SI+5))="0" : N
EXTS$(N(SI+6))="1"
5740 IF (STATE$(N(SI))="1" AND STATE$(N(SI+1))="1") AND STATE$(N(SI+4))="0" AND
NEXTS$(N(SI+4))="1" THEN 5750 ELSE 5790
5750 IF (STATE$(N(SI+2))="1" AND STATE$(N(SI+3))="1") THEN NEXTS$(N(SI+5))="1":N
EXTS$(N(SI+6))="0"
5760 IF (STATE$(N(SI+2))="0" AND STATE$(N(SI+3))="0") THEN NEXTS$(N(SI+5))="0":N
EXTS$(N(SI+6))="1"
5770 IF (STATE$(N(SI+2))="1" AND STATE$(N(SI+3))="0") THEN NEXTS$(N(SI+5))=STATE
$(N(SI+6)): NEXTS$(N(SI+6))=STATE$(N(SI+5))
5790 SI=SI+7
5795 RETURN
10000 REM THIS LISTING DEMONSTRATES THE SIMULATION MODELS
10002 REM THESE DATA STATEMENTS CONTAIN THE MODEL NAME AND INPUT OUTPUT NODE
 NUMBERS
10005 DATA AND,1,2,4
10010 DATA NAND,4,3,5
10015 DATA OR,1,2,6
10020 DATA NOT,3,8
10025 DATA XOR,1,2,7
10027 DATA NOR,7,8,9
10030 DATA END
10031 REM FROM HERE ON IS THE WAVEFORM INPUT DATA
10035 DATA 1,0,1
10040 DATA 1,0,2
10045 DATA 1,0,3
10050 DATA 10,1,3
10055 DATA 50,1,1
10060 DATA 50,1,2
10065 DATA 55,0,3
10070 DATA 60,0,1
10075 DATA 70,0,2
10080 DATA 80,1,1
10085 DATA 90,1,3
10090 DATA 100,0,3
10095 DATA END
```

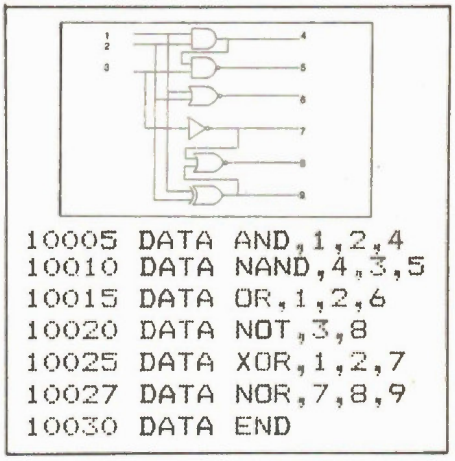


Fig. 4. A logic circuit schematic with numbered nodes, and the resultant Data statements.

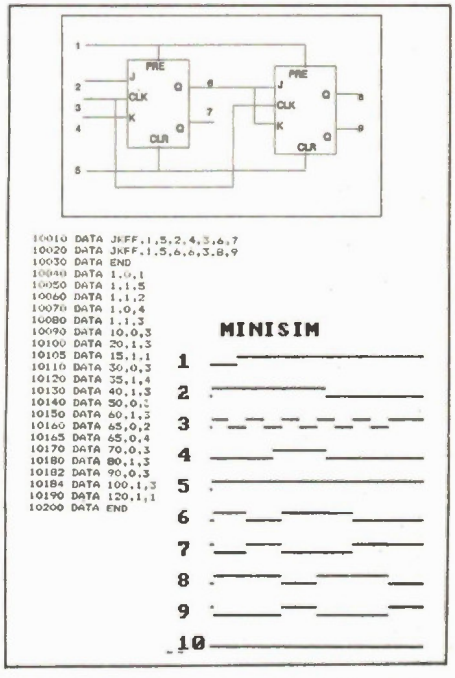


Fig. 5. The schematic of a JK flipflop with numbered nodes, the resultant data statements and the resultant waveforms.

will read the DATA statements at the end of the program and will continue to do so until an "END" statement is found. Fig. 4 demonstrates this procedure: a circuit drawn with the nodes numbered, and the Net-List made into DATA statements. We have also included in Fig. 4B a printout of the output waveforms created by simulating the sample circuit. Fig. 5 gives another example of creating a circuit for simulation and its resultant output waveforms.

Simulating the Circuit

To verify a circuit's function, the circuit must be stimulated. That is, the inputs must be varied in order to exercise the circuit and to verify the output for every input condition. The input stimulation information is entered in DATA statements following the circuit description information. Each DATA statement line must contain a simtime, logic state and node number, as shown in the program code printout starting on line 10030. To help you understand the use of simtime increments we have included an example of some input DATA statements and the resulting timing diagram of the waveforms produced in Fig. 6.

Analyzing the Circuit

Type "RUN" to start the simulation and observe the traces being drawn on the screen. As the circuit is simulated the data is directly displayed on the screen. The "OK" prompt will appear when the program is done. You can now compare the logic states of the simulated circuit with the waveforms you were expecting. The BASIC variable TRACES is initialized to 10, so that 10 nodes will be displayed. If your circuit has more than 10 nodes, enter the more important nodes first so that

they may be displayed. Look back at Fig. 5 for an example of the waveforms that will be displayed on your screen.

Writing Simulation Models

Just about any digital device can be described and simulated. Usually a truth table or a state diagram describes the function of a device. This program contains one functional model which was easily created by translating a truth table into IF THEN statements. The JK Flip-Flop model uses the present state (STATE $), to determine what the next state (NEXTS $), is going to be. This method can be used on just about any digital device you could want to model. Obviously making a model of a micro-processor or any VLSI device would require a great deal of effort and would be nearly impossible since they contain literally thousands of gates and devices.

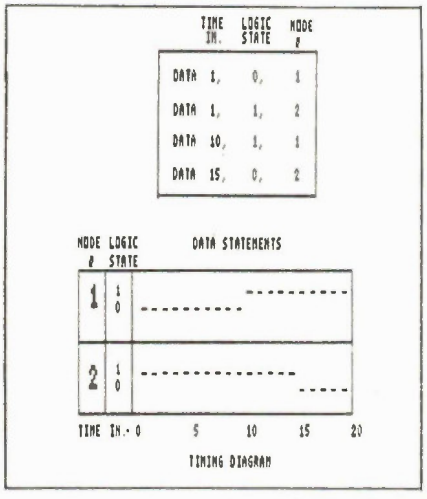


Fig. 6. Data statements and the resultant timing diagram of the waveforms.

Expansion Possibilities

A more sophisticated simulator can be made from this one by including delay times for each digital model, creating your own functional models, storing simulation data to the disk, displaying previously simulated files, and by separating program files from simulation files. You may want to expand our program to include some of these more advanced capabilities, as you explore more digital simulations on your PC.

Code Summary

Lines 500-570
Sets up arrays, initializes the STATE array to 0, initializes the TIME INCREMENT and SIMTIME.

Lines 1000-1310
This routine reads the DATA statements for the models and calls the routine to read in the node numbers.

Lines 1490-2000
This routine reads the DATA statements for the INPUT WAVEFORMS. The TIME, STATE, and NODE VALUES are read into an array.

Lines 3000-3070
This routine saves the MODEL NAME into an array and also reads the NODE NUMBERS into the N(SI) array. This array is used as a pointer to a location in the STATE$ array where the logic state of the node will be kept.

Line 4000-4690
This is the simulation routine which calls the INITIALIZE GRAPHICS routines. It sets all the NEXT STATE values to the PRESENT STATE. Then as long as the SIMTIME is less than the time of the last INPUT WAVEFORM TIME, the simulation process will continue. It starts by checking the INPUT WAVEFORM array and determining if any of the nodes must be changed due to an input for that time. The models for that loop go through the model list at every SIMTIME INCREMENT and call the SIMULATION MODELS needed. These models determine only the NEXT STATE and after all of the models have been RUN for a SIMTIME the PRESENT TIME is then updated to the NEXT STATE. This process avoids having a ripple effect of everything changing at the same time in the circuit.
The GRAPH routine is called and updates the screen for a single SIMTIME. The SIMTIME is incremented and the WHILE SIMTIME loop will continue until the time runs out.

Lines 4700-4730
This routine sets up the screen for medium resolution mode and a blue background.

Lines 4800-4900
This routine will plot a single point (logic state), for the number of TRACES specified by the variable TRACES.

Lines 5000-5790
These are the SIMULATION MODELS. Each routine called will evaluate the inputs to the model and determine what the output logic level(s) will be for the NEXT STATE.

Lines 10000-
These lines contain the DATA statements in which the circuit description is contained and the INPUT WAVEFORM information is contained. ■

Safer Helicopters

System monitoring methods for better maintenance

By Elfan ap Rees, Editor, Helicopter International, UK

Vibration in helicopters is a problem present ever since the first machines astounded onlookers by their primitive attempts to hover, back in the 1930s. Spinning rotors, drive shafts, pumps, generators, gearboxes and powerplants all conspired to unbalance the already unstable flying machine, causing, at the very least, discomfort for the pilot and his passengers and, at worst, stress-induced failures of vital components.

One of the most common causes of vibration was, and still can be, the main rotor blades. Early blades had to be matched as a set to overcome weight and balance differences. Trailing edge tabs needed to be meticulously adjusted by hand to ensure that each blade followed the same track and produced the same amount of lift to avoid an out-of-balance disk.

Checking this balance was traditionally carried out by marking each blade tip with coloured chalk, engaging the rotor drive and then placing a rigid canvas flag in line with the rotating tips - the chalk marks left on the canvas soon told the operator if a blade was out of track. Such rudimentary methods were still common in the 1960s when the development of more sophisticated analytical equipment began.

Improved Understanding

By the early 1970s, several vibration analysis and basic monitoring systems were available, but all had shortcomings. In particular, they were difficult, if not impossible, to use on a helicopter in flight, while their analogue design meant that analysis of problems was lengthy, limited, often subjective and provided no trend data for future consideration.

Today, the causes of helicopter vibration are much better understood and more easily corrected, as a result of new methods of recording and analysing the performance of the dynamic components.

British companies have played a major role in bringing about these changes. One of the leading firms, Helitune of Fleet, southern England, was started in 1978 by Noel Trigg who ended a long career in the Royal Air Force as Chief Helicopter Engineer. Trigg's experience with helicopter vibration led him to develop a comprehensive yet fully portable vibration analysis system now marketed as the Helitune Rotortuner. It is based on a portable data processor unit, linked to an infrared camera, that monitors blade track, and a number of accelerometers mounted inside the cabin to measure vertical and lateral balance and in other areas as necessary.

Magnetic pick-ups on the main rotor shaft provide the system's heartbeat, a one per revolution pulse detecting any rotor mass imbalance and giving a vibration signature, as well as driving the camera. The latter, patented by Helitune, can measure the track of an individual rotor blade to within 1.6mm, so long as it is pointed by the operator to within 10 degrees of the tip. The infrared linescan uses the centre of gravity of the passing blade as the datum, comparing any up or down variations against the mean path.

Limits Indicated

By programming the Rotortuner with information such as the number of rotor blades, gear ratios, number of teeth on each gear and so on, the system is able to pinpoint vibration sources and analyse engine and gearbox performance. Known characteristics of the dynamics system of a particular helicopter type can be built into the analysis, enabling the Rotortuner to identify acceptable limits and inform the operator accordingly.

All data, whether collected in ground running or in flight, is received by the compact computer, analysed, and displayed on a knee pad console. After each test the computer generates hard copies with corrective instructions for the ground engineers. In addition, the data is stored on an individual cassette

for that particular aircraft, enabling an historical file to be built up for trend reference.

To extract maximum benefit from such trending data, Helitune also invites each Rotortuner operator to submit the tapes for central analysis, the results then being shared among all contributing operators.

The benefits of the Rotortuner are perhaps obvious. The rapid identification of vibration sources, and the ease with which the operation can be carried out by relatively inexperienced operators - in the field if necessary - leads to less maintenance, less premature component removals, and longer lives for the various components.

Many Users

As a result the safety factor is markedly increased, while direct operating costs are reduced. All these benefits are already being demonstrated by current Rotortuner operators, including the Royal Air Force, British International Helicopters, the Italian Army, the Canadian Armed Forces, and the United States Coast Guard.

Several of the major helicopter manufacturers also now use and recommend the system. In France, Helitune has signed agreements with SEMIA to market the Rotortuner locally and also to Aerospatiale customers worldwide. Ansofone Elettronica in Italy is to produce up to 200 of the latest Dash 5 systems under licence.

To date more than 40 helicopter types have been configured to the Rotortuner. Data tapes readily available for use range from such giants as the Boeing Chinook and Sikorsky CH-53E to the smaller Aerospatiale Alouette and the Bell AH-1 Cobra. Meanwhile, Helitune is developing a permanent on-board version of the system for application to new generation helicopters.

The concept of permanent monitoring of dynamic components is already being explored by other British companies, including Rotor Dynamics of Coventry in the English midlands. Since 1984 it has been developing an automatic vibration on recording system working in conjunction with laboratory based analytical equipment.

Records of Flight

The Rotor Dynamics system comprises a cassette tape recorder fitted in the cockpit and connected to strategically placed accelerometers and an integral magnetic pick-up. Blade balancing can be carried out by plugging in compatible equipment. Fault diagnosis and data interpretation are completed by using any one of various spectrum analysers, including the Rotortuner and the Solartron 1201.

The relative simplicity of the Rotor Dynamics equipment makes it especially attractive to smaller helicopter operators, who can monitor their aircraft's vibration performance at regular intervals during revenue-earning flights, and then either analyse the data themselves later or send the tape to Rotor Dynamics for a full interpretation.

Another alternative is offered by Stewart Hughes of Chilworth, southern England, whose rotor analysis development system (RADS) is said to be the fastest available. The core of RADS is an automatic blade tracker, which measures data for up to five blades simultaneously on each revolution.

An accuracy of 1 mm is claimed in tracking, while the sensor can also measure lead/lag with a precision of 0.2 mm. The results are automatically stored in a hand-held computer, and can be hard copied or transferred to a base computer or analyser for further use.

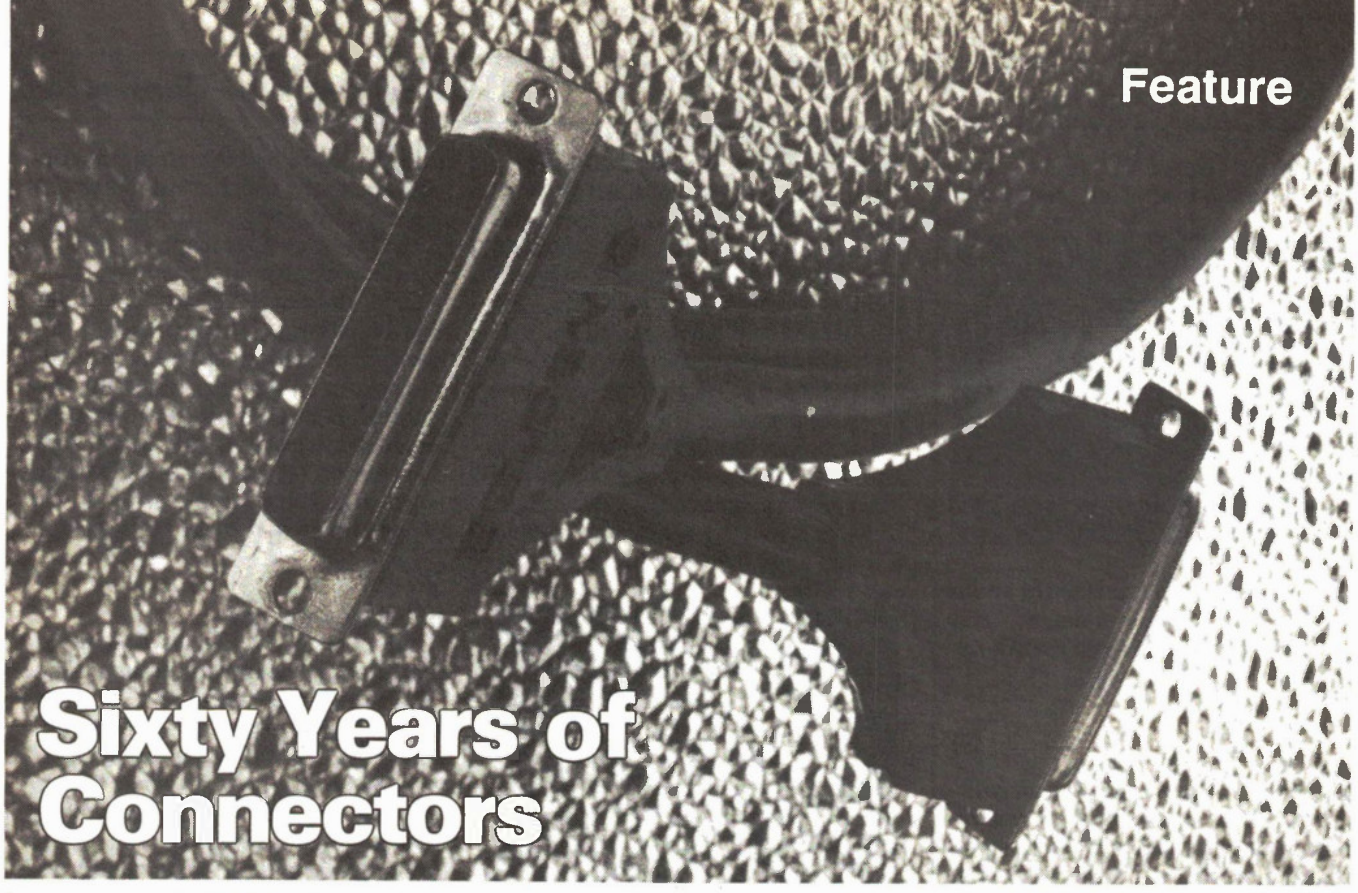
Detailed Check

Probably the most advanced helicopter component monitoring system is that now being developed by Smiths Industries of London, in conjunction with Westland, Rolls-Royce and Southampton University. Known as HUMS (Health and Usage Monitoring System), it uses an on-board computer to process data from the helicopter's engines, dynamic components and airframe, to provide a complete and on-going record of their condition.

This includes fatigue stress, creep, over limit and incident data, as well as detailed vibration analysis, to the extent that even a pitted gear tooth can be identified. All data is stored in a crash proof non-volatile memory bank, with a real time down-link capability to pass data back to a central maintenance facility.

In addition, all the HUMS information is displayed in the cockpit, to give the pilot a continuous readout of the helicopter's performance and potential or actual problems. HUMS is already flying aboard the Westland 30-300, and has been specified by Bristow Helicopters for retrospective installation in its fleet of Aerospatiale Super Pumas. This commercial company is already convinced that the system will rapidly pay for itself in maintenance savings.

Meanwhile, the United Kingdom's Civil Aviation Authority has been watching the development of HUMS and the other component monitoring systems with more than average interest, seeing them as one answer to current helicopter safety and pilot fatigue problems. New airworthiness requirements making such monitoring mandatory may well be just round the corner. ■



Sixty Years of Connectors

From the hand-tightened binding post to today's LSI chip carriers.

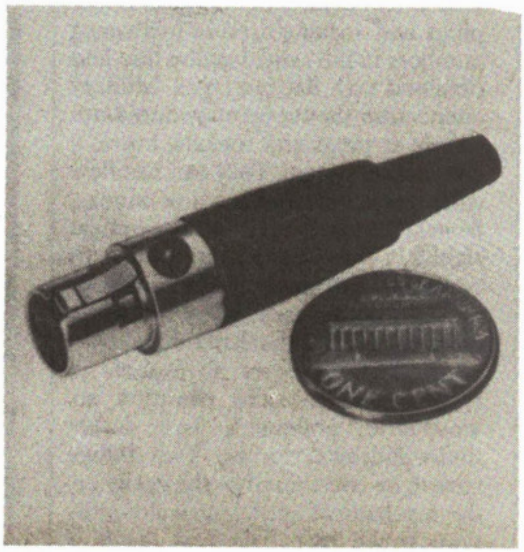
By Dr. H. Virani

The author well remembers the aerial, ground and headphones being connected to the home-built receivers prior to the "cat's whisker" finding the best possible spot on a galena crystal lump. Things were done simply in the 20s, connections being made using milled terminals or drilled binding posts and hand-tightened screws.

Domestic electricity was not universal by any means in the UK, but was beginning to supercede gas, oil lamps and candles. Carbon filament lamps were still common. Connectors were limited to lampholders for bulbs of the Edison screw or bayonet type, both of which have survived. Wall sockets were 2-pin and rated at 2A for lighting purposes.

Gradually the privately-owned electricity companies began to market their product for uses other than lighting, and heavier 2- pin sockets appeared to allow "electric fires" and space heaters to be connected. The electricity sold as "power" merited a different tariff from that sold for lighting. Plugs used turned brass pins split longitudinally to give spring, while the sockets into which they fitted were also cylinders of brass having grooves cut in the sides. Later a third and heavier pin was added, allowing the appliance to be grounded to a pin on each socket.

The modern rectangular cross-sectioned pins were developed during, and came into general use after, WWII. In parallel with this progress, communications were developing, with the telephone service expanding in both the business and domestic fields.

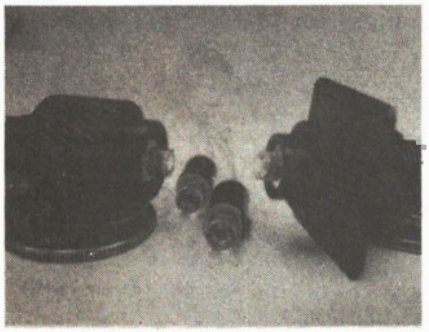


Basic Types

With hindsight it can be seen that connectors as components divide naturally into those that handle electricity as a power source to be distributed to appliances and equipment and, on the other hand, those used for distributing signal and control currents of a low potential, and so it has remained as a general rule today. Wireless, or radio as it came to be called later, was to develop quickly from the 20s up to WWII and became the basis of a whole new industry which made not only receivers, but more and more sophisticated components for both set markers and home enthusiasts, of whom there were many, rather like the home computer boom of today.

Connectors did not form a significant part of this activity, but were to be found in the manual telephone exchange of the day. The British Post Office types 201 and 301 were derived from Western Electric in the US and can probably claim to be the first coaxial connector. The type 301 used the familiar tip, ring and sleeve conductors, together with a plastic sleeve for the user to grip.

Conductors were of brass with ebonite insulation. This connector



was designed solely to handle audio circuits and ringing voltages, and found wide use in PBX and PMBX exchanges.

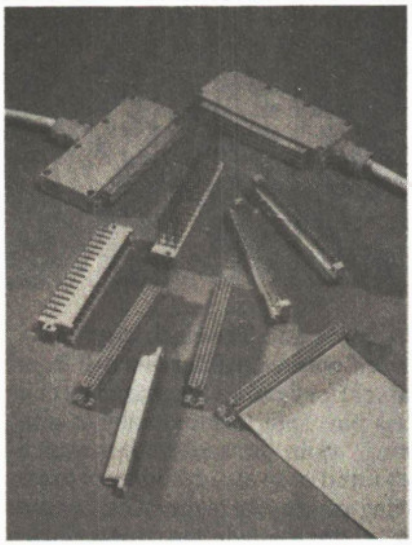
Electronic Connectors

The Second World War gave an enormous impetus to connector development of all types. Before WWII, it was the vacuum tube and the need to connect it into equipment that brought into being a plethora of different socket versions, depending on the whims of the manufacturer. The International Octal (IO) became widely used and had a thermoset plastic base into which were moulded eight hollow pins and a locating spigot. The envelope was cemented into the base after the wires had been threaded down their appropriate pins and the tips soldered. For multiwire connections, the octal form was most often the basis of a similar plug which mated with an octal socket on the equipment to which power or control signals were to be routed.

Flat Pin Connectors

During the war, when "lend-lease" was in operation, much American electronic equipment found its way into Canada and inevitably, American connector practice came with it. Prominent among many was the flat pin multiway design of the Cinch Corporation, often referred to as the "Jones" connector. It had several pin/socket arrangements to provide multiple connections for cable and equipment. By present standards, insertion and withdrawal forces were very high, as anyone who had to struggle with them will remember. Both male and female elements were housed in rectangular moldings which were for either chassis mounting or cable mounting. Metal shield covers enclosed the soldered connections, and cable strain relief clamps fitted the cable outlets on the covers. A center locating pin was often provided. The pins were often silver-plated for better conductivity, but tended to tarnish both in storage and in use, negating the plating benefits.

The design was licensed to Paignton and Co., whose Multicon range became a popular one for teleprinters, "pay-on-answer" phones and various military uses, for which heavier versions with diecast covers were made.



Improvements were relicensed back to Cinch in post-war years and the range has been retained by the present manufacturer.

Military Connectors

The war saw American equipment with metal shell and round multipin plugs and sockets used in increasing numbers in the same fashion that had obtained with flat pin types. Military connectors should be considered not simply as plugs and sockets, but as a connection system. They can handle a wide range of transmission modes, from DC through SHF and also optical signals. They have the ability to withstand extremely hostile environments, in both senses of the word, while meeting high standards of reliability.

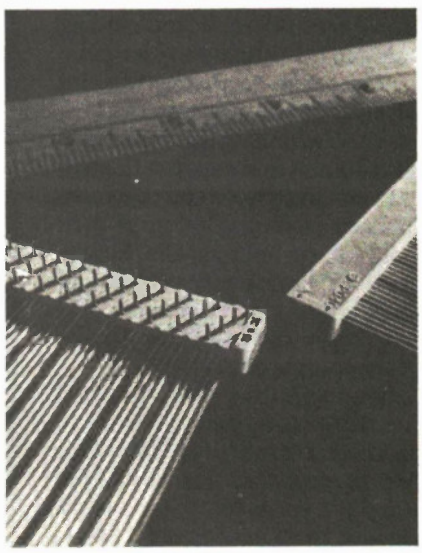
Specifications cover all aspects of temperature, pressure, vibration, atmospheric pollutants and insertion/withdrawal forces. Two things have to be considered by the designer, the mechanical and electrical conditions to be met. The first needs a durable metal shell containing the contact assembly, which must either terminate a multiwire screened cable or provide access to a receptacle fitted in a piece of electronic equipment.

The metal connector shell has a number of keyways corresponding with those in the mating connector. Military connectors make use of keyways, not only to locate the two halves, but also to prevent damage to fragile pins in high-density designs. In all cases, the object is to add extra compression to the joint before positive locking occurs.

PCB Connectors

Undoubtedly one of the biggest impacts on the connector industry since WWII was the arrival of the printed circuit board; the advent of the transistor in the 50s and the gradual departure of the tube forced a whole new approach to component packaging. Those who were involved with the first generation of solid-state mainframe computers (EMIDEC, etc.) will recall how the greater packing density of both active and passive components led to connector problems.

The first PCBs were rectangular cards of either laminate or fibreglass with tracks in copper, often with plated-through holes in which the silver plating itself caused problems such as silver migration. Tracks ended at one of the shorter board sides and two-part connectors were used between the pin half of the board and the female section of the racking frame. Indeed, that practice has carried over until today. Later, PCBs appeared having tracks ending at the board



edge in gold-plated tongues or pads which, in suitable sliding guides, made contact with an edge connector on the frame. These connectors had a line of U-shaped, gold-plated female contacts mounted in phenolic or Delrin moldings, with wires for either soldering or wirewrap projecting through the rear of the molding. Thus a series of these mounted in a racking frame provided a good solution to back plane wiring.

Coaxial Connectors

The coaxial cable has several advantages, not the least of which is that it is greatly superior when used in reception, being immune to both unwanted signals and noise. In a concentric line or cable, the characteristic impedance Z_o is given by

$$Z_o = 138 \log D/d$$

where D is the inner diameter of the outer conductor and d is the outer diameter of the inner diameter. The dielectric is assumed to be air.

Cable impedances have varied over the years and a figure of about 75 ohms used to be the norm, whereas today 50 ohms is regarded as standard both for cable and coaxial connectors. The latter have now become one of the most highly developed components available to the radio engineer.

Optical Fibre Connectors

Most of the connection systems so far discussed are more than adequate for hard-wire applications, and methods are now frequently incorporated in them to combat EMP and RFI. It has become more necessary than ever for the equipment designer to harden his designs against EMP, etc, in view of the vulnerability of today's increasingly complex and expensive semiconductor components.

The arrival of the optical fibre as a transmission medium came almost like the proverbial answer to the maiden's prayer. Fibre bundles in cable form had been in use as light guides for illumination, medical inspection and other purposes, but the single fibre in either monomode or multimode has brought about a revolution in high-speed communications (see Fibre Optics in the May issue). Thus the newest connector developments probably lie in this area, and optical fibre connectors are available commercially today.

The advantages of fibre optic cable has been discussed at length elsewhere: quite apart from being non-radiating and proof against RFI and EMP, the saving in weight over conventional copper is significant, as is the wide transmission spectrum.

The practical problems of joining a fibre are immense, but the last ten years have seen many of them mastered. A fibre can be butt-welded after careful preparation of the ends to be joined and processor-controlled equipment has been developed for this purpose. To avoid unacceptable losses in fibre joints, the fibre ends have to be scribed and broken off cleanly and the end surfaces polished and aligned. Mechanical support of a high order is essential, and this must permeate the whole connector assembly, right through to the protective sheath.

The target insertion loss for the completed connector should be on the order of 1dB, and this figure has been achieved in many long-haul telecommunication circuits. The connectors on the market, while accepting current fibre sizes, have shown varying approaches from military type needs to cheaper versions using molded components.

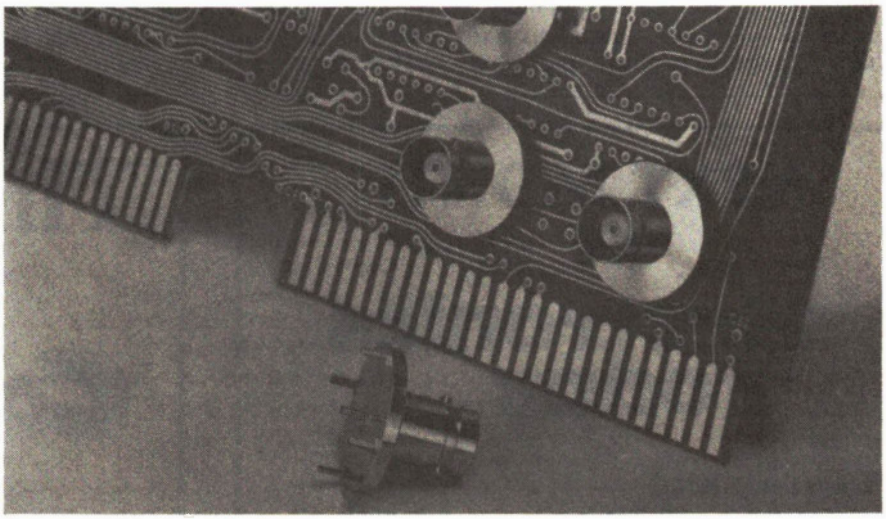
Semiconductors

While the early transistors were mounted on PCBs and flow- soldered into place, the coming of TTL heralded the simple dual- inline package (DIP). It was soon apparent that there would be a need to connect them to the board by way of a socket rather than flow-solder them directly, if only to assist in maintainence.

Now that chips embodying VLSI are with us, much larger sockets are needed. Modern microprocessors have already exceeded 40 pins in the DIP version and similar densities occur where chip carriers are used.

Chip Carriers

Modern VLSI chips are increasingly being presented in carriers. The chip is mounted in the center of a square substrate and has its leads brought to terminating points on all four edges by conducting paths. Two grades are in use: the plastic-encapsulated version with "full wing" shaped legs or "J" formed leads, and hermetically sealed types for military and professional use. Applications for the cheaper plastic version lie in cellular radio and domestic radio phones, and they will undoubtedly find their way into all kinds of home electronics. Both types need a compliant lead structure to overcome the stresses brought about at the stage of soldering to a ceramic hybrid or PCB.



The leadless chip carrier is of even greater importance; this device, often multilayer, is reflow soldered to prepared solder pads on the substrate of a hybrid circuit and is sealed by a gold plate lid. The connection points usually have about 60um of gold on nickel.

Single-layer carriers are epoxy sealed and multilayer versions are her-

metically enclosed. In this way, stacking and higher packing density can be achieved. The current pin spacing is .050", but already there are moves to reduce this to .020" in future as designers face up to even higher pin counts. At present, plastic carriers have between 28 and 68 pins, and the leadless chip carrier, 16 to 84 pins. It is certain that connectors in some form will be part of system assemblies with which future engineers will have to cope.

Conclusions

Looking back, the author in 1980 completed a survey of trends in connector development and the extent to which they would be influenced by the higher processing speeds which VLSI, then soon to arrive, and the increasing packing density in terms of gates- per-chip would have. While the predictions were accurate, the magnitude was somewhat short of the mark.

A need for connectors handling in excess of 100 DIP connections and having more compliant pins was forecast. At that time, it seemed wise to consider connectors of very low insertion and withdrawal forces and even zero-force designs. Pins would be more fragile, with contact plating being highlighted as needing study. The number of pins per connection was clearly increasing and it was realized that all designs would have to include features allowing the ingress of digital probes.

By 1985 a VLSI chip having up to 25,000 gates was a fact. If WSI (Wafer Scale Integration) becomes a reality, it may call for increasing numbers of connections which present chip carriers cannot accommodate, but the signs are that a carrier or larger derivative will emerge. This will most likely be brought about as the need to stack the chips themselves becomes more pressing.

Optical technology will be an important part of the connector industry in future. It is the arrival of the optical processor and its implications that is the subject of a large amount of present effort. Developments are taking place whereby it can be made, in light terms, to perform functions that are certainly familiar to the radio engineer, such as mixing, detecting and frequency changing at optical wavelengths. This gives rise to the need for beam splitting and T-junctions as well as the established connection methods. The future is very clear and one which must both excite and challenge engineers in the 1990s. ■

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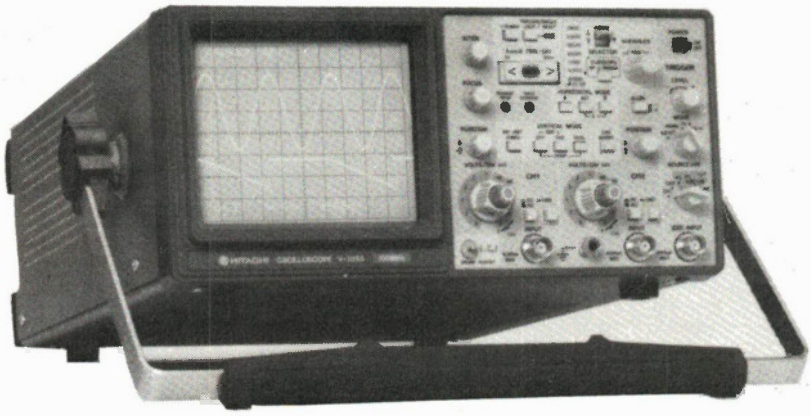
The Hitachi V-1065 Oscilloscope



Advances in microchips produce more features at a lower price.

By Bill Markwick

About four years ago, Electronics Today covered the introduction of a new Hitachi oscilloscope with microprocessor control. It had digital readouts on the CRT and cursors that you could move around to define the signal you wanted measured, and it cost about $9000, though it did include digital storage.

Now Hitachi has brought out the V-1065, a dual-channel compact scope with all the readouts and cursor-measurement features of the one above, with the exception of storage capabilities.

The most remarkable feature is that the price tag is in the $3000 Cdn. price range. Each year the designers of microprocessor systems use the newest generation of microchips and programming techniques to give medium-priced equipment features formerly found only on top-of-the-line gear.

The V-1065 frame consists of a dual-channel, delayed sweep DC-100MHz scope with 2mV vertical sensitivity and a 6-inch screen. One of the most useful of the special control features is the sweep time autorange. This automatically adjusts the horizontal sweep to display 1.6 to 4 cycles of the incoming signal, though it can be set manually with an auto-stepping pushbutton rather than a rotary switch. In addition, the trigger conditions can be locked to the sweep, letting you change the sweep speed with losing the stable trigger conditions.

The cursors can be moved to any area of the signal for measuring voltage difference, time difference and frequency by means of the digital CRT readout. In effect, you have an oscilloscope that gives you a built-in voltmeter and frequency counter, a compact testbench with a handle on it for field or lab use.

The scope is actually a member of a series; it's also available in a 60MHz version (V-665), or in a simpler 60MHz version without the cursor feature (V-660), or a 100MHz version without the cursoring (V-1060). The price range of the new family of scopes is $2000 to $3200, depending on the desired features.

The V-1065 is such a recent introduction that we couldn't get one for a full review for this issue; we had to make do with a quick demonstration, and before we had even started drooling properly, it was whisked off to the next appointment. When the new stock arrives, we'll see if we can't get one for a more in-depth look at how microprocessor meets measuring equipment, and how it can save you a bundle while it gives you a lab-in-a-suitcase.

Hitachi Denshi Ltd. (Canada), 65 Melford Drive, Scarborough, Ontario M1B 2G6, (416) 299-5900.

Circle No. 28 on Reader Service Card

Philips PM3320

The Philips PM3320 digital storage oscilloscope features an analog bandwidth of 200MHz, a sampling rate of 250MS/s for 4ns single-shot resolution and synchronous clocking for two channels. The vertical resolution is 10-bit.

The 200MHz bandwidth and 1.7ns risetime plus pre-triggering allow the scope to detect a 3ns glitch hidden in a lower- frequency signal. Above the timebase speed at which the maximum sampling is used (200ns/div), the scope automatically makes use of a random sampling system.

A function called Restart is used to examine specific parts of a signal. The cursors are set to the desired part of the trace, and on the next trigger pulse, an extended-resolution part of the trace will be shown.

Measurements can be made on-screen; the scope measures time, voltage, frequency, risetime, peak-to-peak, RMS and mean values.

Three memories can be used to store signals, and cursor measurement can be performed on these stored signals.

The user has a choice of displaying only the measurement points (a series of dots) or a display similar to an analog scope whereby the scope interpolates the space between the dots and joins them.

77 combinations of front-panel settings can be stored and recalled using a single number, or they can be recalled in a sequence for automated test procedures.

Optional interfaces include the IEEE-488 bus, IEC-625 interface, RS232C interface and a real-time clock. Prices start at $16,500.

Philips Scientific and Industrial Equipment Division, 601 Milner Avenue, Scarborough, Ontario M1B 1M8, (416) 292-5161.

Circle No. 29 on Reader Service Card

Createc Signal Computer SC01

The Createc SC01 is a remarkable handheld test instrument that looks like a cross between a tiny oscilloscope and a programmable calculator, and that's just about what it is.

The oscilloscope section is a 2-channel, DC-5MHz digital scope displaying on a 128 by 128 pixel LCD that's just over two inches square. This alone would make it a worthwhile investment for troubleshooting, but there's much more: LSI and surface-mount technology allow the unit to be microprocessor-controlled, functioning as a signal-analysis test set.

First, the micro optimizes the timebase, trigger and cursor positioning to suit the incoming signal. It calculates frequency, period and voltages and displays them in a listing at the top and bottom of the screen; preprogrammed settings for specific measurements can be carried out. Waveforms can be stored in memory along with the desired instrument settings.

A-to-D conversion is done by a 7-bit flash converter working at 20MHz; single-shot operation allows a maximum resolution of 50ns or 1us/div. Periodic signals can be displayed at a maximum sweep rate of 50ns/div.

Trigger parameters can be defined by entering the required values, or the unit can set optimum values automatically.

The computer can perform such functions as multiplication of two waveforms, and the unit can also be used as a straight voltmeter or frequency/period meter.

The unit is powered by an external plugpack for use in 120V outlets.

RCC Electronics, 310 Judson St., Unit 19, Toronto, Ontario M8Z 5T6, (416) 252-5094. Also offices in North Vancouver and Pointe Claire, Quebec.

Circle No. 30 on Reader Service Card

Leader LBO-325 Portable Scope

The LBO-325 is a 60MHz, dual-channel, dual timebase portable oscilloscope. Though it doesn't have a battery pack option, it's small enough to fit in an attache case (9 by 3 by 11 3/8 inches). The 9-lb unit has a calibrated timebase with alternate sweep that permits viewing the main signal and magnified details at the same time. Risetime is 5.8ns and the vertical sensitivity is 5mV/div. The sweep rates are 0.2us/div to 0.2s/div in 19 steps, with main, delayed, alternate main and delayed time bases; A and B traces are separated via a front panel control.

Other features include a x10 magnifier, 3% accuracy, an internal calibrator, a front panel cover, a carrying case and a CRT hood for the 3.5" CRT.

For less demanding applications, it is also available as the LBO-323 with 20MHz operation.

Omnitronix Ltd., 2410 Dunwin Drive, Unit 4, Mississauga, Ontario L5L 1J9, (416) 828-6221.

Circle No. 31 on Reader Service Card

Leader LCD-100

A true portable, the LCD-100 has the features of an oscilloscope plus a digital multimeter, together with operation from rechargeable Nicad batteries. The display is a 64 by 192 dot LCD with the range settings displayed on the left side in alphanumeric characters. It is unaffected by the electromagnetic fields that might be encountered in industrial use.

The scope section is a 200kHz/10mV digital storage type with automatic sweep, triggered sweep and single sweep. Three storage memories and one work memory are provided for waveform storage; a backup battery protects the contents of memory for up to one month after the power is turned off. The vertical resolution is 6 bits (64 points) and the horizontal is 8-bit (256 points). Auto- ranging can be switched into the timebase if the input signal lies between 50Hz and 200kHz.

The multimeter section is electrically isolated from the scope (including the ground circuit) to prevent any short circuits or electrical hazards due to their connection to separate signals. This requires that the DMM section be run on separate batteries (2 AA cells).

The DMM measures DC voltages from 320mV to 1000V full scale, AC voltages from 3.2V to 750V full scale between 40 and 500Hz, DC and AC currents to 320mA full scale, and ohms from 320 ohms to 32 megohms full scale. The resistance range can be switched to a low power mode which will not forward-bias semiconductor junctions.

The LCD display features large, easily readable numbers about 5/8" high when switched to the DMM mode. In either mode, the contrast is front-panel adjustable.

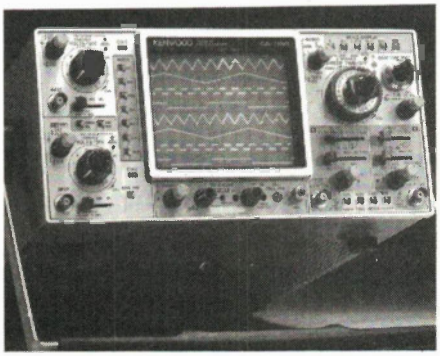
The LCD-100 comes with a carrying strap, probes and an AC adapter/recharger. Optional equipment includes a carrying case and a cable for the external triggering function.

Omnitronix Ltd., 2410 Dunwin Drive, Unit 4, Mississauga, Ontario L5L 1J9, (416) 828-6221.

Circle No. 32 on Reader Service Card

Kenwood CS-2150 Oscilloscope

The CS-2150 oscilloscope is a comprehensive, 4-channel, 8-trace unit designed for use in areas such as broadcast satellites, compact disks,



design automation, factory automation, local-area- networks and office automation. It will handle professional applications not covered by 100MHz scopes.

The four input signals can be swept simultaneously with the main sweep. In addition, each of the corresponding delayed signals can be displayed simultaneously, allowing magnification of each input waveform. Two timebases are available, allowing the simultaneous observation of two signals varying widely in frequency.

An accuracy of 2% and a sensitivity of 1mV/div provide precise vertical inputs. Other features include bandwidth limiting to 20Mhz to eliminate high-frequency components, a switching power supply to reduce weight and eliminate a voltageselector switch, a comprehensive trigger section for viewing of difficult signals such as video, and a switchable chopping frequency.

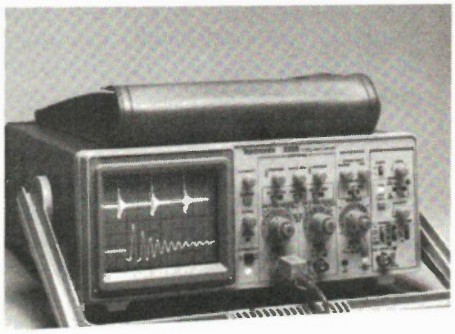
The control settings are selected by LED-illuminated pushbuttons and electronically switched by the internal CPU. A lithium battery provides back-up of the switch settings when the power is removed.

Navair Limited, Instrumentation Division, PO Box 214, Malton Postal Station, Mississauga, Ontario, (416) 676-4150.

Circle No. 33 on Reader Service Card

Tektronix 2225 Portable Oscilloscope

Tektronix has introduced the 2225 Portable Oscilloscope for field service, manufacturing and production and educational applications. The



dual-channel, 50MHz scope is a low-cost addition to the popular Tektronix 2200 series.

Features include alternate magnification (magnified and unmagnified sweep on-screen simultaneously), 500uV sensitivity, a peak-to-peak trigger mode and high-frequency, low-frequency trigger filtering. The trigger section includes selective triggering on TV lines or TV fields, ideal for television or video applications.

The extra vertical sensitivity makes the scope ideal for such uses as testing amplifier noise, power supply ripple, transducers and tape heads. In addition, the vertical channels can be used in a differential mode or in an add mode.

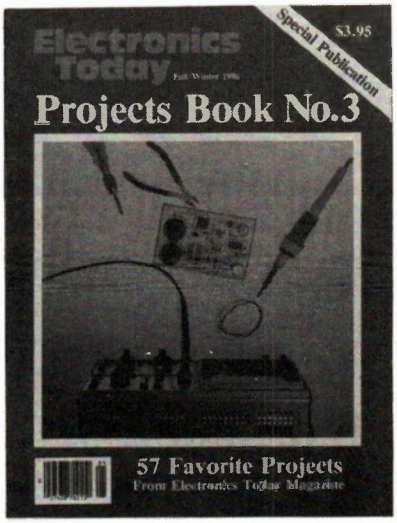
Also new is the trigger filtering capability. With this feature, users can selectively filter out unwanted low or high frequency components from the trigger signal, such as removing the low-frequency component of a signal in order to view a high- frequency component.

The Canadian price is $1759, duty and FST included.

Tektronix Canada Inc., Marketing Communications Department, PO Box 66500, Barrie, Ontario L4M 4V3, (705) 737-2700. Circle No. 34 on Reader Service Card

ORDER PROJECTS BOOK NO. 3 Today!

Hobby Projects was first published in the summer of 1980 and contained 25 Electronics Projects reprinted from Electronics Today magazine. It was a sell out and was followed in January 1981 by Projects Book No.2 and in the summer of 1983 by 50 Top Projects, both of which were also virtually sell outs.



Projects Book No.3 has now been compiled and is off press and available for order by telephone or mail. Cost is $3.95 (plus $1.00 postage). Bulk rates on requests.

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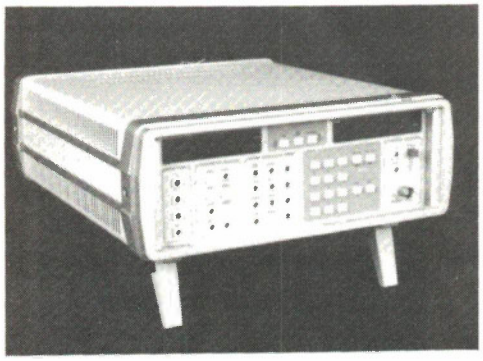
Moorshead Publications, 1300 Don Mills Road, North York (Toronto), Ontario M3B 3M1.

Frequency Generators

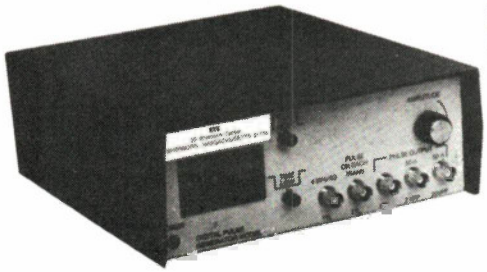


OR-X Function Generators

Brunelle Instruments has been appointed representative for the OR-X company, manufacturers of laboratory class function generators. The OR-X function generators are IEEE compatible. The basic features are 99 stored settings, GPIB programmable, fully protected input/outputs, 4-digit sythesizer accuracy, sweep up/down, single or continuous modes, and simultaneous display of frequency and level. For more information on OR-X generators, contact:

Brunelle Instruments Inc., 69, 6th Range S., St-Elie d'Orford, Quebec J0B 2S0, (819) 569-1408.

Circle No. 35 on Reader Service Card

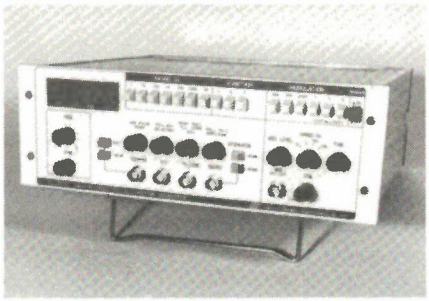


King KI2512D Generator

RCC Electronics announces the addition of the King Function Generator to its line of King Instruments. The 2512D features five waveform outputs with a range from 0.2Hz to 2MHz. It has modulated outputs and is also a 6-digit frequency counter. For more information, contact:

RCC Electronics Ltd., 310 Judson St., Unit 19, Toronto, Ontario M8Z 5T6, (416) 252-5094.

Circle No. 36 on Reader Service Card

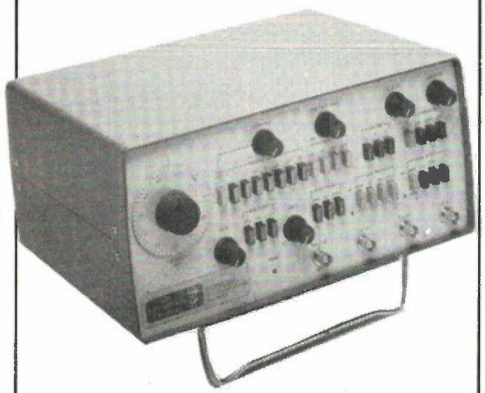


ETE Model 400

The ETE Model 400 Digital Pulse Generator is a computer- controllable or stand-alone crystal-controlled instrument with independently settable high and low pulse periods from 250ns to 999.75 minutes. An RS-232 interface and .005% accuracy make it ideal for the ATE environment. Outputs are standard TTL, 2V 50- ohm or 20V 50-ohm. Timing adjustments are set by thumbwheel.

BCS Electronics Limited, 980 Alness Street, Units 6 and 7, Downsview, Ontario M3J 2S2, (416) 661-5585.

Circle No. 37 on Reader Service Card



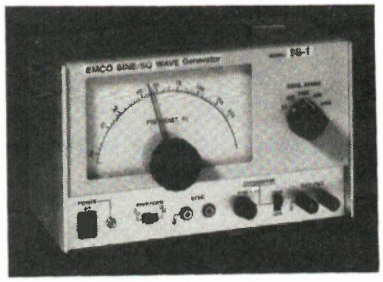
OK Model 207

The OK Model 207 Pulse/Function Generator provides sine, square and haversine waveforms from 0.005Hz to 5MHz plus pulse waveforms over the same range. Additional features include continuously variable symmetry (duty cycle) to 19:1, trigger-gate modes with variable phase from -90 to +90, external sweep input to 1000:1 and 2 outputs, TTL and 50 ohm. A switchable attenuator allows -2- and -40dB attenuation of the output; DC offset is adjustable to 20Vp-p.

Pulse width is variable from 50ns to 50ms and delay is varibale from 100ns to 50ms. Modes include normal, double pulse and delayed, which offsets the output relative to the trigger input.

Len Finkler and Co., 80 Alexdon Road, Downsview, Ontario M3J 2B4, (416) 630-9103.

Circle No. 38 on Reader Service Card



Emco SS-1 Generator

The Emco SS-1 is a general-purpose sine/square generator with both signals available simultaneously. The range is 20Hz-200kHz squarewave and 20Hz-2MHz sinewave. FET stabilization is used to ensure a maximum distortion of 0.25% across the audio range. THe sinewave output can provide 7.5V RMS into a high impedance load or 6.5V into a 600-ohm load. The square wave is 0-10Vp-p into a high impedance, positive going with zero ground.

H. Cowan Canada Ltd., 99 Coons Road, Box 268, Richmoind Hill, Ontario L4C 4Y2, (416) 773-4331.

Circle No. 39 on Reader Service Card

The **LBO-315** battery-powered, portable 60MHz oscilloscope from Leader is designed to meet the field service engineer's requirements of small size, light weight and battery operation.

Weighing only 10lbs. including the battery, this unit will operate from a self-contained 12V battery, an external DC source from 10 to 20V, or from 85

to 264VAC without rewiring or external switching. The transformer will also operate from 50 to 400Hz, making it ideal for aircraft maintenance.

This 2-channel unit contains such features as: sweep functions for simultaneous display of the main and delayed time bases, and alternate triggering for simultaneous viewing of asynchronous signals. The display is a 3 1/2 inch PDA CRT with 12kV accelerating potential and an illuminated graticule for clear, bright , well-defined traces.

Omnitronix Ltd., 2410 Dunwin Drive, Unit 4, Mississauga, Ontario L5L 1J9. Circle No. 40 on Reader Service Card

Multimeters

The model **5000 Digital Wattmeter** gives a direct reading of true power, AC or DC volts, and AC or DC current on a 3 1/2 digit LCD display. The unit is ideal for school experiments and appliance repair shops.

Key features of the model 5000 are: high measuring accuracy; reads true power, not apparent power; LSI circuitry; light weight; and measures up to 6000 watts. The unit also features automatic zero adjust on current and voltage settings.

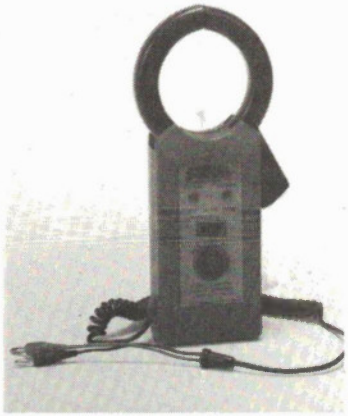
Brunelle Instruments Inc., 69, 6th Range S., St. Elie D'Orford, Quebec J0B 2S0. Circle No. 41 on Reader Service Card

From Metex we have the **Model 3630** DMM. This instrument is a compact, rugged, battery operated, hand held, 3 1/2 digit multimeter for measuring DC and AC voltage, DC and AC current, and resistance. The unit is also designed for doing diode, capacitance, transistor hFE and continuity tests. The dual-slope A/D converter uses CMOS technology for auto-zeroing, polarity selection and overrange indication. Full overload protection is provided.

The unit is ideal for use in the field, laboratory, workshop, hobby and home applications.

R.P Electronics, 2113 West 4th Avenue, Vancouver, B.C. V6K 1N7

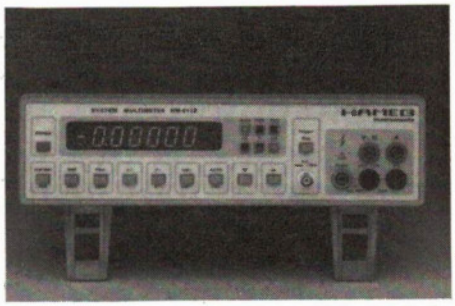
Circle No. 42 on Reader Service Card



The model **89 AC/DC Clamp On Adaptor** is a handy add- on that allows your digital multimeter to accurately measure AC or DC currents up to 400 Amps. There is no need to break the circuit, just plug the banana plugs into almos any DMM and clamp the jaws around the conductor in question. The opening of the jaws is a maximum 1 1/2 inches.

Typical uses include checking discharge and charge current of batteries in automotive repair applications and checking AC or DC power distribution systems in industries. Powered by a standard 9V battery.

Brunelle Instruments Inc., 69, 6th Range S., St. Elie D'Orford, Quebec J0B 2S0. Circle No. 43 on Reader Service Card



Hameg's **HM8112**, 6 1/2 digit DMM features include true RMS, 1 G-ohm

input impedance, IEEE-488 interface buss with built-in self test, auto or manual ranging, plus electronic calibration via keyboard or via IEEE-488 buss. Resolution is 100nV, 1m-ohm and 10nA with digital offset correction.

A 4-pole, 10 channel scanner, controllable via the IEEE-488 or keyboard is available as an option. The HM8112 also matches with the Hameg Modular System 8000 test equipment.

BCS Electronics Ltd., 980 Alness Street, Unit 7, Downsview, Ontario M3J 3S2

Circle No. 44 on Reader Service Card

The Megger model **BM-14** is a battery-operated, multivoltage insulation and continuity tester for testing distribution networks.

The unit has a range of 0 to 10,000 Meg ohms at 5,000 volts and 0 to 5,000 Meg ohms at 2,500 volts. A voltage discharge circuit has also been built into the unit to provide a high level of user protection. The BM-14 is particularly suited to systems with voltages ranging from 11kV to 33kV. Weight is 1Kg.

Metermaster Division of R.H. Nichols Co. Ltd., 80 Vinyl Court, Woodbridge, Ontario L4L 4A3.

Circle No. 45 on Reader Service Card

Escort's model **ECT-640** is designed for lighter current applications. It has a jaw opening of just under 1 1/4 inches or 31mm. It can measure AC volts to 750V, resistances in a range of 200 ohms with 1 ohm resolution, and also has a continuity buzzer.

Metermaster Division of R.H. Nichols Co. Ltd., 80 Vinyl Court, Woodbridge, Ontario L4L 4A3.

Circle No. 46 on Reader Service Card

The **Fluke 20 Series** of handheld multimeters are ideal for use in almost any environment because they are totally sealed against dirt, water, contaminants and chemicals.

Both the Fluke 25 and Fluke 27 offer 0.1% DC accuracy, and they combine a 3200-count digital display, with a 31-segment analog bar graph for quick measurements of stable or changing signals. Additional features include fast autoranging, audible continuity/diode test beeper and Fluke's unique "Touch Hold" display. The Fluke 27 also includes MIN/MAX recording and Relative (difference) modes. Both units feature a separately sealed battery/fuse door, for easy access without breaking the primary case seal.

Electronic Wholesalers Ltd (Produits Electroniques en gros Cie Ltee); 1131 Newmarket Street, Ottawa, Ontario K1B 4N4.

Circle No. 47 on Reader Service Card

The **DM850** from Beckman Industrial features an easy to read 4 1/2 digit LCD readout and is capable of measuring

frequencies up to 200KHz with a resolution of 10Hz (1Hz on the 20KHz range) and DC volts to 0.05% accuracy with a resolution of 0.01 mV. The DM850 also has true RMS measuring capability, AC coupled, to provide accurate readings of non-sinusoidal waveforms.

AC voltage can be measured to 750 volts, DC voltage to 1000V, AC and DC current to 10 amps, resistance to 20 megohms, and frequencies to 200KHz. An audible continuity checker is also standard. The case is full size for easy handling and easy reading of the front panel and includes a bail.

Blakewood Electronic Systems, 201-5725 Carnarvon Street, Vancouver, B.C. V6N 4A7.

Circle No. 48 on Reader Service Card

American Reliance Inc.'s **AR-460D** handheld 3 1/2 digit LCR meter with dissipation factor is capable of measuring inductance from 200uH to 2H, capacitance from 200pF to 200uF, and reistance from 200 ohms to 20 megohms.

Accuracy in the capacitance mode is 1% + 1 in the 200pF to 2uF range and 2% + 1 in the 20uF and 200uF ranges. Inductance range accuracy is 2% + 1 in the 200uH range, 1% + 1 in the 2mH to 200mH range, and 2% + 1 in the 2H range.

The unit also features a "LOBAT" and decimal annunciators in the display, and line operation is also possible with a 9V AC/DC adaptor. Standard Accessories are one pair of test probes, spare fuse and operation manual. Price: $310 (FST in).

BCS Electronics Ltd., 980 Alness Street, Unit 7, Downsview, Ontario M3J 2S2. Circle No. 49 on Reader Service Card

The **AR-170NL** from American Reliance is a true RMS AC measurement device with a level measuring range of -70dBm to +60dBm. It is also capable of noise measurement with its 3KHz flat weighing filter.

The device also features 10 amp AC/DC capability, ACV and DCV, resistance up to 20 Mohms, audible continuity and diode check.

The display is a 0.5 inch, 3 1/2 digit LCD type with "LOBAT" and decimal annunciators. Powered from either a 9V battery (typical 200 hours/Alkaline type) or by an AC/DC adaptor. Price: $215 (FST in).

BCS Electronics Ltd., 980 Alness Street, Unit 7, Downsview, Ontario M3J 2S2.

Circle No. 50 on Reader Service Card

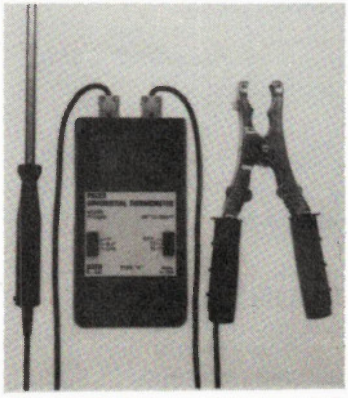
In applications where temperature measurement is a necessity, the **Fluke 50 Series** hand held digital thermometers offer good all around performance.

Both the Model 51 single-point, and the Model 52 scanning and recording dual-point thermometers offer a convenient "HOLD" function, Fahrenheit/Celsius conversion, and complete flexibility between K and J type thermocouples. Each unit comes complete with a general purpose bead probe (two with the 52). Operating time is 1200 hours on a standard 9V battery.

Added features of the Model 52 are: ability to measure and display the temperatures at two sources as well as their difference; a "SCAN" function to cycle through T1, T2, and T1-T2; and functions for recording and viewing minimum and maximum temperatures.

Allan Crawford Associates - Marketing, 5835 Coopers Avenue, Mississauga, Ontario L4Z 1Y2.

Circle No. 52 on Reader Service Card



The PT2000D differential digital thermometer from Pacer Industries Inc. allows the measurement of two temperature sources and is capable of calculating and displaying their difference.

The unit is a "K" type thermocouple thermometer that is accurate to within one-half degree and has an average response time of 2.5 seconds. The PT2000D measures from -85 degrees Fahrenheit to +2000 degrees Fahrenheit and its sister version, the PT2100D measures in the -65 to +1150 degree Celsius range.

Duncan Instruments, 121 Milvan Drive, Toronto, Ontario M9L 1Z8.

Circle No. 53 on Reader Service Card

The Brunelle **model 2300 Digital L/C meter** is a combination inductance and capacitance meter in one light-weight, hand held unit. Reading the inductance of a coil or the value of a capacitor is made easy by the digital LCD display.

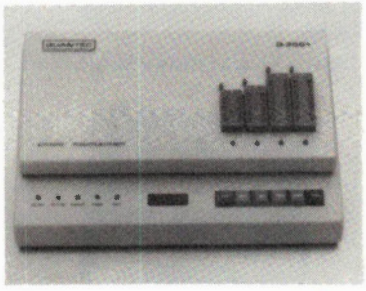
The unit features the following: high measuring accuracy even in strong magnetic fields; input overload protection; a 3 1/2 digit LCD display; five inductance ranges (2mH to 20H); and six capacitance ranges (2nF to 200uF). It can be useful in school experiments, designing new circuits and in service and repair facilities.

Brunelle Instruments Inc., 73, 6th Range S., St. Elie D'Orford, Quebec J0B 2S0. Circle No. 54 on Reader Service Card

Worn video heads can easily be diagnosed with the **model 600 Video Head Tester** from Brunelle. The unit is an analog style meter designed for determining the amount of wear and condition of a video head. VCR service technicians can use the meter indication as a guide as to whether or not a video head should need replacement.

The model 600 features include: light weight portability; a 1MHz measuring frequency; battery operation (10 hours on a standard 9V); three ranges to cover all types of VCR heads. The unit is available for testing either Beta or VHS types of heads.

Brunelle Instruments Inc., 73, 6th Range S., St. Elie D'Orford, Quebec J0B 2S0. Circle No. 55 on Reader Service Card



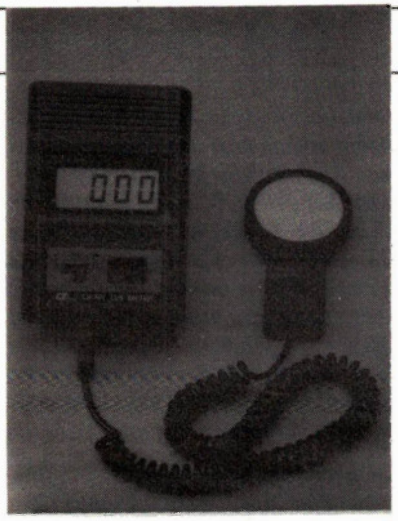
The **Quantec Q-2000 Multi-Programmer** is an advanced state of the art programming system, capable of programming hundreds of devices from Single Chip Microprocessors to PALs. The Q-2000 mainframe unit contains all the basic hardware and power supplies necessary to handle all current and future devices through the use of Family Modules. For example, by simply plugging the EPROM Module into the top of the mainframe, the user can configure the Q-2000 to program a particular family of components such as NMOS, HMOS, and CMOS EPROMs, and EEPROMs including 40-pin single chip microprocessors.

Other modules are available to support an extensive line of devices such as PALs, FPLAs, PLAs and IFLs as well as bi-polar PROMs.

Interfax Systems Inc., 3395 American Drive, Unit 12, Mississauga, Ontario L4V 1T5.

Circle No. 56 on Reader Service Card

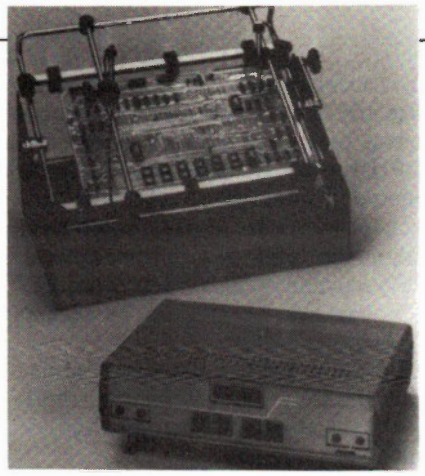
The **Model LX101 Lux Meter** is an ideal unit for light measurement in commercial studios, offices, classrooms, factories, production and warehouse areas. Three meter ranges are provided offering greater flexibility and resolution.



The LX101 features an LCD display, low power consumption, separate light sensor for "limited space" applications, and auto- zero adjustment. Included with unit are the separate light sensor, instruction manual, battery and carrying case.

Duncan Instruments Canada Ltd., 121 Milvan Drive, Toronto, Ontario M9L 1Z8.

Circle No. 57 on Reader Service Card



The **Shortec 2020** PCB shorts locator system finds the precise location of shorted etchs, easily, quickly, and inexpensively, on bare or loaded boards.

By placing the defective PCB on the Shortec fixture, and the spring loaded probes on the two shorted nodes, the Shortec will then measure the resistance of the short and slowly ramp up voltage and current to safe levels, to heat the short. The precise location of the short is then indicated on heat sensitive film. The unit is suitable for single and multilayer boards. Price: $2890US.

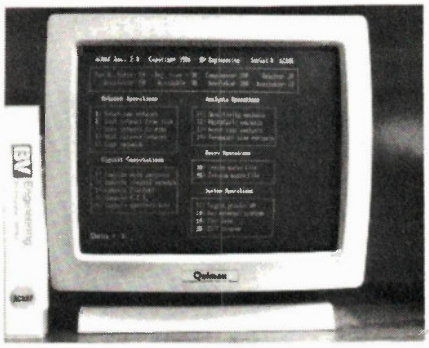
Ken Berquist, 17 Cummings Park, Woburn, MA 01801 USA

Circle No. 58 on Reader Service Card

The power supply **HM8040** from Hameg has been designed as a constant current and voltage source for laboratory and test field use. Providing 3 floating, independent output voltages, it is ideally suited for complex low-power analog and digital applications. Two outputs can be continuously varied between 1.3 and 20 volts, the third providing a constant 5 volts. Current limiting is also adjustable. Transistion from voltage regulation to current regulation is automatic and will be indicated by an LED in the display.

BCS Electronics, 980 Alness Street, Unit 7, Downsview, Ontario M3J 2S2

Circle No. 59 on Reader Service Card



Circuit analysis by computer is made easy with the **ACNAP3** general purpose AC Circuit Analysis Program from BV Engineering. ACNAP3 analyzes electronic circuits consisting of resistors, capacitors, inductors, transistors, op amps, FETs, transformers etc. Circuits up to 200 components and 50 nodes can be analyzed in a single pass; larger circuits can be chained. ACNAP3 features include: unlimited length user-definable macro operations, double precision accuracy, unattended AUTO execute and BATCH mode operations, subcircuit capability, iterate component value capability, execution of external programs from within ACNAP3, and component libraries.

ACNAP3 is available in PC/MSDOS and Apple Macintosh versions for $125US.

BV Engineering, 2200 Business Way, Suite 207, Riverside, CA 92501

Circle No. 60 on Reader Service Card

NIC-320

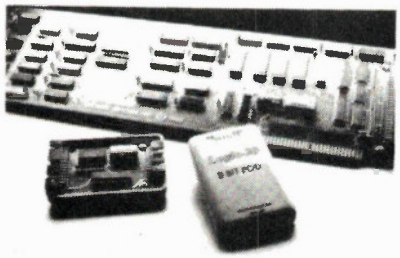
As featured on our cover, the Nicolet NIC-320 offers flexible triggering and two 10MHz digitizers making for easy transient capture. Also, its 200MHz sampling mode allows high speed repetitive signals to be stored and examined at leisure.

Both live waveforms and saved reference waveforms occupy a full 4000 data points in memory. Stored data can be transferred to a bubble cassette for later recall and analysis or output to a computer via IEEE-488 (GPIB) or RS-232 interfaces. Fully annotated digital plots offer the advantage of report-ready documentation at the press of a button. Analog XY recorder or strip chart recorder plots can also be created for simple hard copy records.

Specialized data collection routines allow the NIC-320 to become a standalone, automatic data acquisition system. Price: $13,000.

Nicolet Instruments, 1200 Aerowood Drive, Unit 1, Mississauga, Ontario L4W 2S7.

Circle No. 61 on Reader Service Card



The **Logic-20** from BitWise Designs will turn any IBM PC or compatible into a 20MHz logic analyzer by simply plugging a card.

The standard sampling rate of the unit is 20MHz, with a minimum period of 50 nanoseconds and a trace size of 16 bits by 256 words. With the optional Doubler pod, the sample rate is increased to 40MHz over eight channels, with a trace size of 512 words. The external clock has a 5 nanosecond minimum pulse width and a 2 nanosecond set-up time. An internal clock provides 18 rates from 40Hz to 20MHz. Two external sampling pods provide the Logic-20 with either 16 channels of sampling or, optionally, eight channels of sampling with glitch detection.

Techmatron Instrument Inc., Suite 111, 833 The Queensway, Toronto, Ontario M8Z 5Z1

Circle No. 62 on Reader Service Card

The Protech **PRO-1990** is a knowledge-based system that utilizes artificial intelligence to provide rapid, accurate and comprehensive PC board fault detection. Designed to meet the needs of the electronic service industry and electronics manufacturers, the system becomes more expert at diagnosing board problems at the component level as more boards are tested. Features of the PRO-1990 include: integrated standalone computer- based test system, IBM-AT compatible; high resolution graphics display; 44 megabyte high-capacity disk; two 360 Kilobyte and 1.2 megabyte floppy drives; 1M dynamic RAM; parallel and serial ports; graphics printer; and two asynchronous communications ports to support modem or terminal connections up to 9600 baud.

Techmatron Instrument Inc., Suite 111, 833 The Queensway, Toronto, Ontario M8Z 5Z1.

Circle No. 63 on Reader Service Card

From Huntron we have the **Tracker 5000** computer- controlled troubleshooting system. The unit is a complete tabletop circuit tester that employs a personal computer as the user interface and test automation device.

The system identifies substandard or faulty components by applying an AC test signal to the device under test, developing a test response signature, and reporting any abnormal responses. Test procedures are menu driven, cued by on screen prompts with HELP screens available at all times.

The Tracker 5000 can use any IBM PC, XT, AT or compatible with a single 5 1/4 inch disk drive and hard-disk storage of at least 10Mbytes, with a minimum of 512Kbytes of RAM. A parallel printer port and RS232 I/O port are also required.

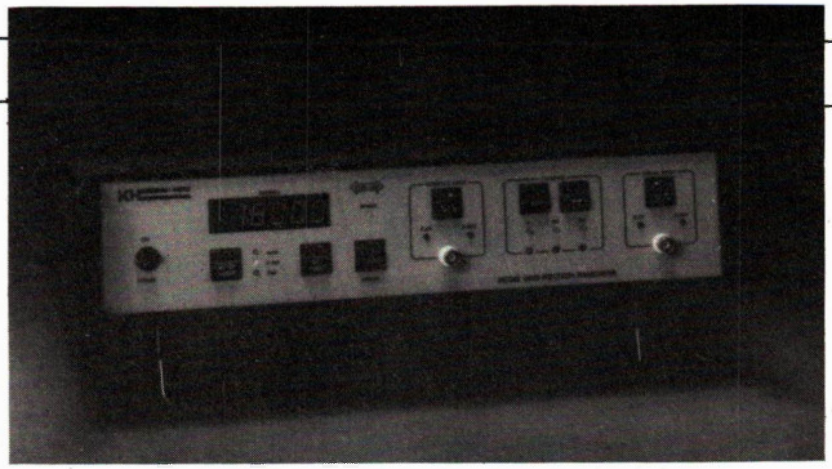
Gerry Cyprus, Cyprus Products Inc., 7648 Heather Street, Vancouver, B.C. V6P 3R1. Circle No. 64 on Reader Service Card

Fluke's Millionth

The one-millionth model 70 series handheld multimeter emerged from Fluke's Everett, Washington assembly line recently. The 70 series has become the most popular family of handheld meters in the world. The gold-encased Fluke 77 will be placed in the company's headquarters plant museum. For further information on Fluke products, contact:

Allan Crawford and Associates, 5835 Coopers Avenue, Mississauga, Ontario L4Z 1Y2, (416) 890-2010.

Circle No. 65 on Reader Service Card



The **Krohn-Hite Model 6620** precision phasemeter is IEEE-488 programmable and provides phase angle measurements with a typical accuracy of 0.02 over 5 decades of frequency, with 0.01 resolution.

Operating over the frequency range of 10Hz to 10MHz (1Hz optional), the unit measures sine, square, and triangle input waveforms and pulses of greater than 50ns, with input voltage levels of 10mV to 320 Vrms. An automatic correction mode provides instant correction of phase readings for zero and full scale errors, making phase measurements more accurate and reliable. A five digit LED display provides continuous readout of phase angles in 0.00 deg./360 deg. or plus/minus 180 deg. ranges.

Standard features include: a relative measurement mode for monitoring of phase deviations; an automatic selection of input voltage range; and an analog output. An RS232 option is available to replace the IEEE-488 interface.

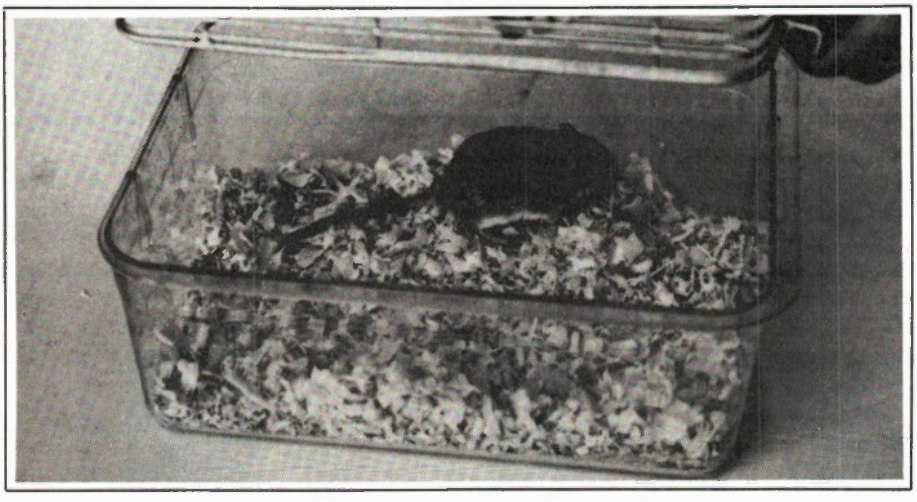
Roger Webster, Webster Instruments Ltd., 1134 Aerowood Drive, Mississauga, Ontario L4W 1Y5. ■

Circle No. 66 on Reader Service Card

Of Mice and Microchips

Using the computer to simulate animals in laboratory testing.

by Peter Ellaway and Trevor Poole



All those concerned with animal welfare will welcome any new methods that eliminate or reduce the need to use live animals in experiments. The latest development in this field in Britain is the creation of biological computer programs which simulate actual physiological experiments. These are now becoming available commercially and the Sheffield BioScience program "Nerve Physiology" will be taken as an example.

The Sheffield BioScience teaching package developed at Sheffield City Polytechnic in northern England, is a self-contained computer program aimed at students in the first year of a biological science degree, in medical and dental courses, or those such as speech sciences, physiotherapy and nursing.

Instruction is by means of a computer simulation designed to replace the conventional practical class where electrical recordings are made from an excised sciatic nerve of a frog. The package consists of a 127 mm floppy disk to be run on a 32K BBC-B microcomputer, and an instruction manual with notes both for students and tutors. The hardware needed to run the simulation is simply a BBC-B computer, disk drive and video monitor.

Hard copy prints of the graphic display of action potentials may be obtained on a printer if the computer is fitted with a Printmaster read only memory, but this facility is not necessary for successful use of the material. Indeed, one of the strengths of the program is that students are encouraged throughout to make their own measurements of voltage and time from the video screen.

Form Analyzed

Suggestions are then offered as to how these results may be plotted or used in calculations of, for example, nerve conduction velocity. The material covered by the program includes a discussion of the electrophysiological technique that needs to be used to investigate nerve function. Only the essentials are presented so that the student is not burdened with unnecessary information during the introduction to the topic.

The program then proceeds to a series of simulations which are presented to the student as experiments. These analyse the form and properties of a mass action potential elicited by electrical stimulation of a mixed sensory and motor nerve. The concepts of refractory period, conduction velocity and directionality of propagation are then examined in experiments where the student is invited to select the stimulus parameters to be used.

The effect on nerve function of temperature and of application of a local anaesthetic are also investigated. When the student has completed the package he will also be aware of the differences between the artificial nature of the electrically induced action potential and the function of nerve axons in living organisms.

The computer program is well structured and a few minutes spent reading the instruction manual provides all the information needed to work through the program without further assistance. The program is menu driven and contains clear and positive instructions. Its self-instructional nature means students can work on the material in their own time, easing the timetabling load if the availability of microcomputers is limited.

Although the program is self-contained, the student is clearly expected to have some knowledge of nerve structure and function before attempting this simulation.

Simulation Cheaper

The teacher considering using this material will wish to know whether it

provides an adequate replacement for the traditional practical class. The advantages of the simulation are clear. There is considerable expenditure involved in purchasing frogs, providing specialist equipment such as oscilloscopes and in man-hours, both technical and academic, needed to run the practical class.

Its use is a substitute for experiments on living animals and, in addition, the cost of running the computer simulation is considerably less since the programs are reusable and the computer equipment will undoubtedly be used for a variety of tasks. The question really is whether it is good enough to replace the live practical.

In this case it can be said to have provided a creditable alternative, consisting of a number of data files containing the actual voltage time course of action potentials recorded in a live experiment. The files are retrieved from the disk when the user decides how a particular experiment is to be run.

The video display unit monitor screen is composed of a graticuled area, which simulates an oscilloscope screen, and a number of prompts or instructions about the experiment in progress. The data base is extensive enough to provide all the material students would expect to encounter in a live experiment and the provision of real profiles of nerve action potentials should encourage them to question the material in depth.

Another lifelike feature of the program is the facility to change the voltage scale and time base of the graticuled screen, which encourages the user to experiment with the data provided and so gain more insight.

Repeated Use

The seven different experiments cover all the aspects of nerve behaviour that are taught in the conventional frog sciatic nerve practical. Although the student is advised to work through the program in the sequence provided in the menu it is possible to enter the program at any point and this will be a useful facility for advanced students or for revision.

Each component of the program is self-contained and the user is referred back to the menu of options at the completion of each experiment. There is no restriction on the number of times an experiment may be run or the order in which experiments are attempted. This flexibility will allow students of different ability to work through the material at a pace suited to themselves.

The decision as to whether a class should use this computer simulation of nerve conduction rather than a live practical will depend on whether the extra experience afforded by the real experiment is not of value. Obvious exclusions from the simulation are the dissection of the sciatic nerve and the subsequent care of the tissue that would normally be carried out by the student during the class.

The experience to be gained by the dissection is debatable but is certainly not negligible. Living tissues are delicate and it is important that students of biology or medicine appreciate that mechanical damage, desiccation or exposure to inappropriate body fluid substitutes will harm a structure such as a nerve. These issues are not neglected entirely in the program. There is, for example, an experiment devoted to the effects that change in temperature will have on the conduction of action potentials.

Welcome Expected

This simulation of nerve function provides a comprehensive and lifelike alternative to the practical class. It is easy to use, inexpensive and utilizes a microcomputer which is available in most laboratories in the United Kingdom. PAVIC Publications also plans to introduce an IBM compatible version for both British and overseas markets.

Sheffield BioScience will shortly release a further disk on the physiology of the frog gastrocnemius muscle. A number of computer programs of this type are in private use in colleges and universities but these have been written by specialists for their own teaching work and are not generally available.

This type of teaching aid will be welcomed by everyone concerned with the welfare of laboratory animals. It should help to reduce the number of animals used in laboratory experiments, and even in situations where the use of living material is unavoidable, prior use of the program will ensure that the student is better informed on experimental procedures and the interpretation and understanding of results. ■

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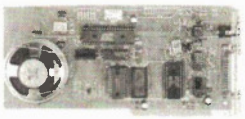

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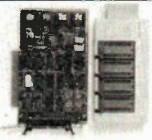

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Washer Fluid Level Warning

An empty windshield washer bottle could become a thing of the past with this simple add-on.

By T.R. de Vaux-Balbirnie

A dirty windshield and empty washer bottle is a combination which every driver has encountered at some point in his or her driving lifetime. Driving in poor weather conditions can result in the washer fluid becoming used up very quickly; not only can it be frustrating, but it can also be very dangerous.

This unit delivers a "bleep" each time the washer is used if the fluid has fallen below some predetermined level, allowing time to refill at the next service station etc.

Circuit Description

The circuit diagram for the Fluid Level Warning device is shown in Fig. 1. IC1 is a 555 timer connected as a monostable. This means that once triggered by making pin two low (supply negative voltage), the output (pin three) goes high for a certain time then reverts to low. Pin two is normally kept high since the potential divider R5 and R6 applies almost 12V to it. The time during which the output remains high depends on the values of C3 and R7; with those used, it will be approximately one second.

The circuit receives current from the existing wires feeding the washer pump motor so that when this is operated, IC1 pin two receives a momentary trigger pulse as C1 charges through R5. Note that Fig. 1 shows the washer motor switch in the positive battery wire but there will be no difference in operation if it is on the negative side.

The trigger pulse will have no effect if IC1 is disabled by keeping the reset input (pin four) low and this is the case when there is sufficient fluid in the reservoir. Then, probes A and B situated in the bottle, are effectively short-circuited by the water which is a reasonable conductor of electricity. Base current then flows to TR1 turning it on. The collector (IC1 pin four) is thereby kept low and IC1 is disabled.

With a low water level, there is no conducting path between A and B so TR1 remains off. The collector is then high and IC1 is allowed to operate. Diode D1 prevents possible damage if the circuit is connected with the wrong polarity. Also, in conjunction with C4, it smooths the supply from

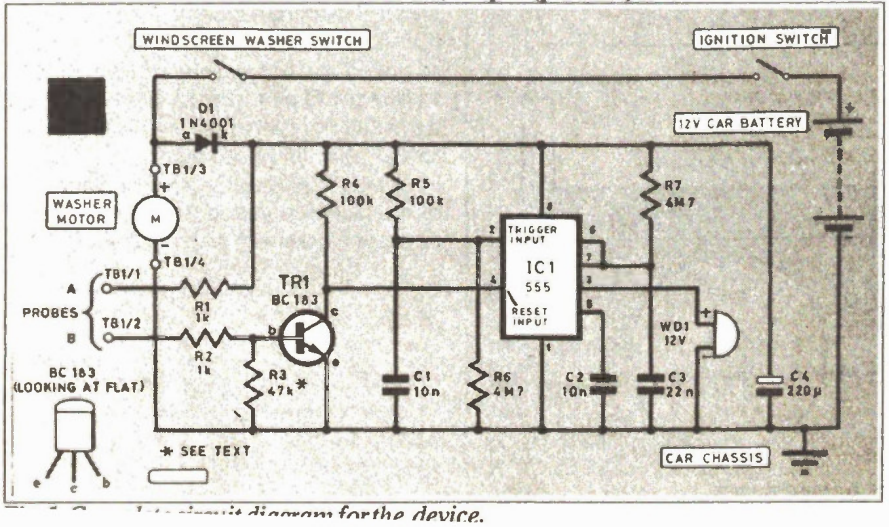


Fig 1. Complete circuit diagram for the device.

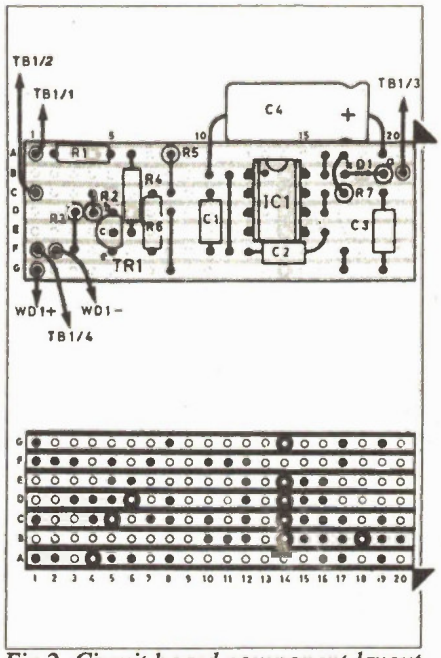


Fig 2. Circuit board component layout and details of breaks to be made in underside copper tracks.

the charging system and allows for correct operation in cases where the washer switch contacts do not "make" cleanly.

Construction

Construction is based on the layout shown in Fig. 2. This uses a piece of 0.1 inch matrix stripboard, seven strips by 20 holes in size. Begin by making the breaks in the copper tracks and solder-

Parts List

Resistors

R1,R2.....1k
R3.....47k
R4,R5.....100k
R6,R7.....4M7

Capacitors

C1,C2.....10n
C3.....22n
C4.....220u electr. 16V

Semiconductors

D1.....1N4001
TR1.....BC183 or 2N5825
IC1.....555

Miscellaneous

WD1, 12V solid-state buzzer - see text; TB1, 3A terminal block - 4 section; 0.1 inch matrix stripboard, size 7 strips x 20 holes; case to suit; connecting wire; stranded wire for probes; 3A automotive wire.

ing the link wires as indicated. Follow with the on-board components including the IC socket. Do not insert IC1 itself until construction is complete. After a careful check for errors, particularly for accidental bridging of adjacent copper tracks, solder 10 cm pieces of light-duty stranded connecting wire to strips A, B, C, F (2) and G as shown.

Prepare the case by drilling a small hole for the wires passing through to the terminal block, TB1. Mount TB1 on the side using two small screws. Attach the circuit panel to the side and the buzzer to the base of the box with adhesive fixing pads. Refer to Fig. 3 and complete all wiring.

Most small solid-state buzzers may be used except for the "driven" types which are not suitable. A high-intensity buzzer should be used if the unit is intended for a vehicle where the washer system is situated near the driver (louder output). The lid of the case may be drilled with a matrix of holes, if necessary, to allow the sound to pass through.

Probes

For the prototype unit, the probes consisted of a piece of twin stranded wire as shown in Fig. 4. This has the advantage of being easily replace if the need arises. The wire is passed through a small hole drilled in the top of the washer bottle. Fit this with a rubber grommet to grip the wire and keep it at the required level. Decide on a suitable place for the unit behind the car's dashboard. Connect the probes to TB1/1 and TB1/2, then connect TB1/3 and TB1/4 to the positive and negative terminals respectively of the washer pump motor using automotive-type stranded wire of at least 3A rating. If the polarity of the motor is not known, connect it up either way and test the unit for correct operation. It will not work with if it is connected the wrong way around.

If the motor is fitted with spade terminals, the additional wires may be added using piggy-back converters. Many cars, however, use a special block converter. In this case attach the new wires, if possible, using connectors which do not involve breaking the wires. These are available from automotive parts shops such as Canadian Tire. Wherever wires pass through a hole in metal, a rubber grommet must be used.

It now only remains to test the system under real conditions. Note that R3

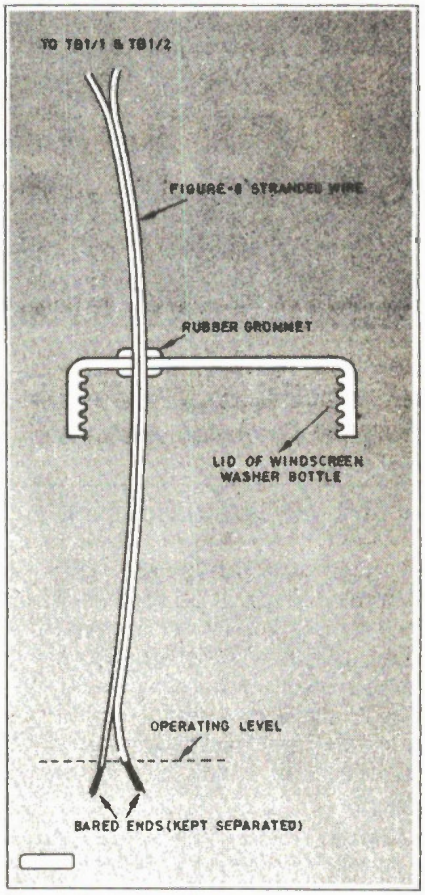


Fig. 4. Suggested arrangement for using twisted wire pair as the level sensor probes.

determines the sensitivity of the circuit. If the buzzer sounds with the probes in the fluid, R3 should be increased in value. If, on the other hand, it fails to sound when the probes are removed and are just slightly damp, its value should be reduced. Do not alter the value of resistor R3 unless a check reveals that there are no circuit faults, however. When testing, allow a pause of at least 10 seconds between operations for capacitor C4 to discharge. ■

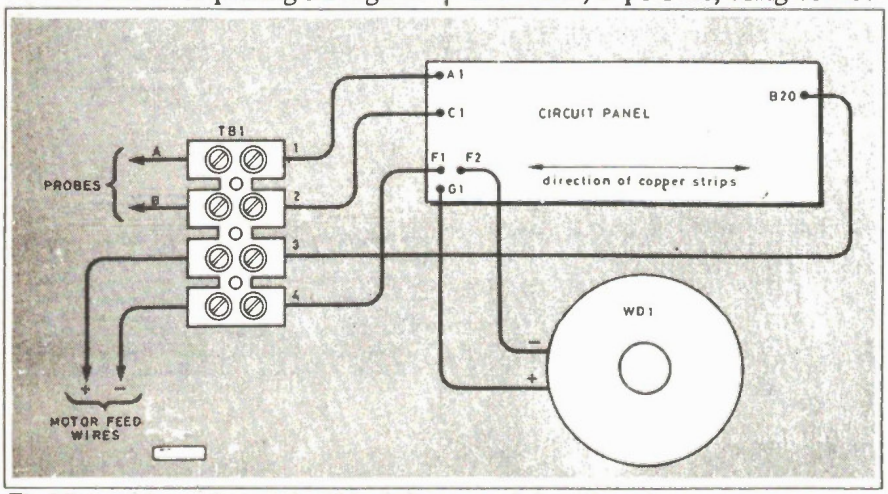
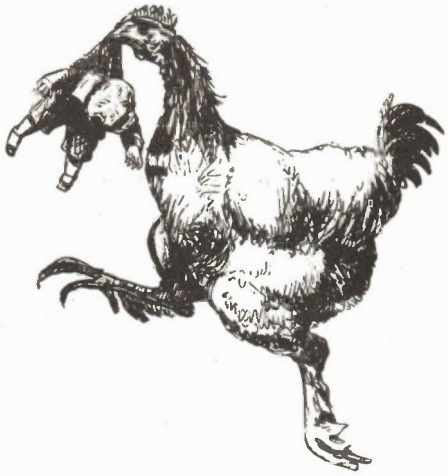


Fig. 3 Interwiring to the terminal block, buzzer and circuit board.

ALMOST FREE
PC SOFTWARE VOLUME XXIII



This edition of our almost free PC software is an especially good value... it features two disks for the price of one and a half. We've expanded it in order to be able to include the latest version of the phenomenal PC-Write word processor, a package which outperforms just about everything else in creation... and costs a great deal less. We've also come up with a powerful collection of utilities and a very strange game. These two disks include some really splendid software, things that you'll probably wonder how you survived without once you get into using them.

All of this profound software, plus its attendant documentation and support files, is available for a mere

$29.95

plus seven percent Ontario sales tax.

ARCE A really tiny archive utility, this thing will extract members from ARC files without tying up half a disk for itself.

BABY An extremely warped game, this thing is engaging and fairly challenging none the less. It involves catching babies who are leaping out of a burning building.

CHMOD This is a useful utility for reading and changing the bits in the DOS mode flag.

CITYDESK This is a really elegant fancy printing program that allows you to do some desktop publishing functions with a dot matrix printer.

DOG A disk organizer, Dog will defragment the files on your disks to make them quicker to access.

THRILL There is little to say about this program. It's a beautiful example of high resolution PC graphics, and was too good to ignore even if it is wholly useless. It's also a bit naughty.

PC-WRITE The latest version of this phenomenal word processor, this thing is enough to turn you off any other word processing package on the planet. Even if you only write ribald limericks in pig latin once every four years you owe it to yourself to try PC-Write.

MIDI-IO This is the source file for the interrupt driven MIDI communication module from the April 1987 edition of Computing Now! Requires MASM to assemble and a language compiler to use... preferably C.

FPR This is a printing program written in C. It's not compiled... you can change it to suit your needs. Requires a C compiler.

EDWIN This is a decent windowing program editor written in Turbo Pascal. It's not terribly fancy, but it's fast and very much like WordStar.

PLEASE NOTE

This volume has been compressed in order to get all this software onto two disks. It will uncompress out to three floppies. This isn't terribly weird... there's a batch file to handle all the work for you... but plan to spend a while watching it run before you can use your software. When you get this disk set, place the first disk in drive A: of your PC and type INSTALL B, for example, to unpack the files onto a floppy in drive B:

ALMOST FREE
PC SOFTWARE VOLUME XXIV

AC This is a very small area code program... give it a three digit area code and it will tell you were it is. The C source is also included.

ASC This is a memory resident utility that pops up a window with an ASCII character chart.

ATTR This utility lets you meddle with the attribute bits of your files.

BAC This is a disk backup utility that's a lot less frightening than the one that comes with DOS.

BACKSCRL This recalls stuff that has scrolled off your screen. It's neat if you can't seem to reach the Num Lock key in time.

CAT This is a collection of disk utilities in one program.

CLOCK One of the nicest screen clocks we've seen, this has a built in alarm function among other things.

CDVER This is a sorted disk directory that prints out all the files on a floppy in a form suitable for sticking to the sleeve.

CWEEP This is a menu driven file mover... saves typing the word COPY over and over again.

DDIR Yet another directory utility, this does a two column directory similar to the regular single column DOS version.

DELZ This wipes out files so that they can never come back... kills the sectors as well as the directory entry.

DISKCAN This one checks your disks for bad sectors... get 'em before they get you.

DOORS This lets you flip between multiple monitors without rebooting your system.

EQUIP This program tells you what hardware your system thinks it has... very often providing you with the answers to all sorts of software problems.

FASTDISK If your floppies seem a bit tedious you might want to zap 'em with this speed up program.

FDATE This changes the time and date stamps of files.

FLIP This one sets a number of otherwise tedious parameters under DOS.

FREE This returns the amount of free space on a disk without having to watch the whole directory scroll by.

GERM This is a memory resident interrupt driven telecommunications terminal.

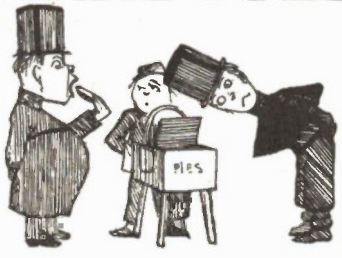
HMSHELL This allows you to fool your system into loading COMMAND.COM from other places.

KBBUFF This is a keyboard buffer extender. No home should be without one.

KEYFAKE This allows you to "stuff" keyboard characters into an application to get past tedious introductory screens and menus.

LC This counts the number of lines in a text file.

LOCATE This scans through subdirectories checking all the files for specific text strings.



LOCK This is a file encryptor. Also includes UNLOCK.

MOVE This moves files between subdirectories with less typing than COPY would entail.

NDOSEDIT An updated version of regular DOSEDIT, this is a resident DOS command line editor that actually makes DOS decent to work with. Indispensible.

NO This is a strange little wild card exception thing. It allows you to create more complex file specifications than does DOS all by itself.

NPAD This is a simple memory resident note pad.

PCUTIL This is a collection of add ons to DOS.

PINHEAD This is the tiny printing press program from the June 1987 edition of Computing Now!. It can get up to sixteen kilobytes of text on a single page. Includes the C language source... works on an Epson compatible printer.

POPCAL This is a memory resident utility which will bring up a calendar for any month of any year you like.

PR This is a handy formatted printing utility.

PUSHDIR Primarily used in batch files, this allows you to change subdirectories, do something and then return to the previous directory.

REBEEP A replacement for PAUSE, this is a noisy batch file utility to attract attention when a task has been completed.

RENDIR This renames subdirectories.

SCRN This is a screen saver... it blanks all the monitors attached to your system after a specified number of minutes of inactivity to keep your phosphor from getting fried.

SETPRN This allows you to painlessly set up your printer form DOS.

SETUP This is a memory resident utility that will allow you to set up an Epson compatible printer from within any application.

SIZE This returns the number of allocation clusters a file occupies on a disk.

SOUND This makes weird noises to attract attention from within a batch file.

SP This is a really nice little print spooler.

SWEEP This allows you to execute a command in every subdirectory on your disk.

UNDEL This recovers accidentally deleted files. You may not need it now but you sure will sooner or later.

VDL This requests verification before it deletes files so you won't need UNDEL quite as often.

VOLSER This changes the value name of a disk.

WAITN This pauses for a specified time while executing in a batch file.

WHEREIS This finds files in subdirectories. It includes the C source code from the June 1987 edition of Computing Now!.

XDEL This is a menu driven file deletion utility.

Little Programs of the Gods

This is one of the most useful disks we've ever done. It has no phosphor monsters, no pinball games, no spreadsheets and no unspeakably complex three way menu driven cranial capacity measurement programs. In their place, we've collected a plethora of utilities and bits of code. These little guys are classics... each one of them designed to make your PC a bit more useful. There are enough DOS assistants here to create a whole new operating system, and a sufficient assortment of memory resident trolls to account for most of the alternate key combinations on your keyboard. There are a number of things here that no enlightened user should be without. Some of these programs are updated versions of things on earlier almost free PC software disks.

Despite the enormity of this list, all of this profound software... plus its attendant documentation and support files... is available for a mere

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E2GEM A small resident utility that allows graphics software written for the Epson FX-80 to render their visual glory on the not quite Epson compatible Gemini printers.

VMAC4 This program allows PC users with Hercules compatible cards... or ATI multiple monitor boards... to look at MacPaint pictures. The Herc card has a more usable aspect ratio than the colour card, and the images look pretty slick. Among other things, there are an awful lot of naked ladies living in MacPaint Files.

PINBALL3 The weirdest pinball game we've encountered thus far, this thing will zap your brain if you play it late at night. It's mildly damaging the rest of the time.

MAXHEAD This is a MacPaint picture of Max Headroom for VMAC4, above. There were several more... and rather more exotic... pictures on our disk number twenty-two, which will also work with VMAC4. Likewise, this file will work with the MacShow colour card program on that disk, which can be used to convert it for use in other PC graphic software.

Long Words and Tongue Twisters

The theme of this month's disk is antidisestablishmentarianism. After scouring the bulletin boards for countless hours, we've managed to find a whole circus worth of programs which are related in that they all have absolutely nothing to do with antidisestablishmentarianism. Tied together by this obvious common characteristic, these files will occupy a profound bit of disk space in your system. A rich assortment of utilities, serious applications and amusements, you won't want to be without these powerful packages. By a remarkable coincidence they have nothing much to do with interstellar snail ranching either.

All of this profound software, plus its attendant documentation and support files, is available for a mere

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IT The "Ideal Terminal" is a telecommunications terminal package which, among other things, emulates several professional mainframe style hardware terminals. It also handles XMODEM and KERMIT file transfers, making it a much less freaky replacement for the likes of QMODEM and CrossTalk.

SPKR A device driver, this little beast allows you to make the PC's speaker play music in a very elegant, program independant way. It's suitable for use with BASIC, C, TurboPascal, assembler and even just from DOS.

RIGHT HAND MAN This is a sort of enhanced public domain SideKick. It provides one with all sorts of pop-up utilities from within other programs, including an ASCII table, a really powerful calculator, a DOS shell and several notepads. It also handles keyboard macros. A clever overlay system allows it to keep its memory consumption down to a manageable hugeness.

SLOWDOWN A lot of software... mostly games... which has been written to run normally on a PC switches into maximum overdrive on an AT or even a fast PC. This usually makes it useless. The slowdown program allows you to bring the speed of such a machine back down to sublight levels for these occasions.

RESQ You probably won't need RESQ until something nasty happens to your computer, but then you'll be very pleased that it's about. This thing can recover erased files and, more important, it can find text that you've lost in memory due to a software crash and get it back into a file. It's indispensible.

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Stock Boy II

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The original StockBoy inventory control package has been one of our most popular programs. However, written in BASIC several years ago, it's no longer really the state of the art. As such, we've rewritten StockBoy from the ground up.

The result is a comprehensive, powerful package of software to keep track of your stock without countless forms or unreliable manual procedures.

StockBoy II has been written entirely in C, making it fast and portable. It will run on any PC, XT or AT compatible. It uses full screen editing to make it simple and carefully designed hard formatted data files to make it faster than you'd have thought a database manager could be. It uses DOS level I/O, so it will run on a network or through a terminal. It will cope with over thirty thousand items without even breathing hard.

Most of all, StockBoy II is easy. It's easy to set up... there's nothing to configure, no tedious installation programs and, as with all our software, no annoying copy protection. It's also easy to use, with plenty of features designed to avoid human errors.

- StockBoy II will maintain an inventory database, allowing you to add, edit and delete items. It also has a powerful item search facility.
- StockBoy II has a complete point of sale terminal module. It will accept stock numbers and bring up complete stock information instantly. It will also adjust your stock files as items are ordered, print up invoices and keep a log of your transactions.
- StockBoy II also features a reporting module to help you maintain an overview of your inventory. It will tell you when your stock has exceeded preset minimum and maximum levels, and what items are out of stock. It will also provide you with important demographics to help you see what's selling and what isn't.

For many small businesses, StockBoy II is the equal of inventory control systems costing hundreds or even thousands of dollars. However, unlike other commercial packages, StockBoy II will run on even a simple PC... on floppy disks if your inventory is small enough... and its price won't break you.

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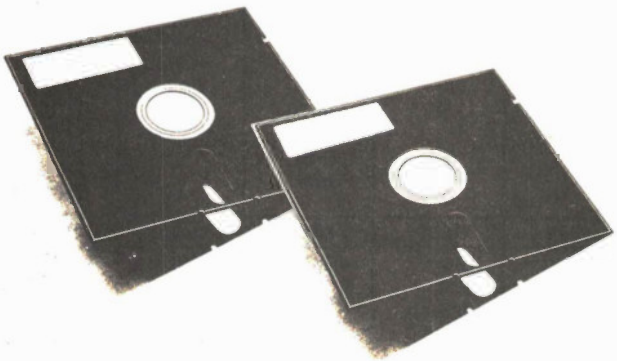

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Renewable Energy Revived

New interest in a topic from the 70s.

by Claire Neesham, Modern Power Systems, London

Britain still burns coal for most of its electricity generation. Nuclear power provides around 20% of the total, and renewables, such as hydropower, a mere 2%. Yet despite the government's commitment to expand the nuclear industry, there is increasing activity in the field of renewable energy.

The oil crisis of the 1970s acted as a strong reminder that fossil fuel resources were finite. Like many other countries, Britain set up a renewable energy research programme to study the feasibility of a variety of devices designed to convert energy from natural resources such as the sun, waves and wind into usable power.

The program continued with considerable government funding, but then interest in renewable energy diminished as oil prices plummeted. Now the increased awareness of the effects of acid rain, a universal problem, and questions about the safety of nuclear power - which was reinforced by the recent nuclear power plant accident at Chernobyl - have made renewable energy an important issue again.

More funding for the United Kingdom's tidal energy program was recently announced. Energy Secretary Peter Walker said: "Tidal energy is one of the country's most promising renewable energy resources."

Promising Sites

An extra 5.5 million pounds is to be spent on further investigations of potential tidal power sites, mainly on the River Severn in western England and the Mersey estuary at Liverpool in the northwest.

Britain has some of the best sites in the world for capturing the energy of the tides. Trapping water behind a barrage at high tide and releasing it through turbines to generate electricity is not a new idea - indeed it has been considered for over a century - but the current investigations are being carried out by two private consortia. The Severn Tidal Power Group (STPG) and the Mersey Barrage Company (MBC) are both preparing reports.

If constructed, the Severn scheme could provide 5% of the country's electricity needs at a competitive price. The Mersey project is expected to have about a tenth of this capacity. A survey is also being carried out on some 120 estuaries with tidal power potential around one tenth that of the Mersey scheme.

Wave Turbine

Large tidal schemes may be possible for example in Morecambe Bay, in northwest England; Solway Firth, 100 km further north; and the Wash, in eastern England; but these have been assessed as less economically attractive.

While money has flowed into tidal power, the funding for wave power has been reduced. However despite reduced finance, researchers at Queen's University, Belfast, Northern Ireland, have developed a small turbine capable of producing electricity at competitive cost for island communities.

As for the mainland, hydropower schemes which use water to turn turbines are already providing 2% of the country's electricity. In all, there are about 50 large and 20 small hydro projects in Britain, but future developments of this well developed technology will be limited to relatively small

schemes as most large sites have already been exploited.

An under-exploited energy source is the wind. Although the United Kingdom has plenty of it, wind power was not a serious contender for large-scale generation until recently. Estimates now suggest that onshore wind generators could supply 20% of the country's electricity at a competitive cost.

Widely Used Design

Several British companies are researching devices for harnessing the wind, with financial and practical help from the Department of Energy and the Energy Technology Support Unit (ETSU).

The horizontal axis wind turbine design is already making a small contribution to the national power supply and James Howden Ltd. of Scotland and Britain's Wind Energy Group are the country's leaders in this technology.

A different approach to harnessing the wind is the vertical axis turbine which has blades that can be altered to control the power output. A moderate sized prototype, built by VAWT Ltd, a consortium of civil engineer Sir Robert McAlpine and Sons Ltd and turbine manufacturer NEI, has just been inaugurated and is being tested by ETSU.

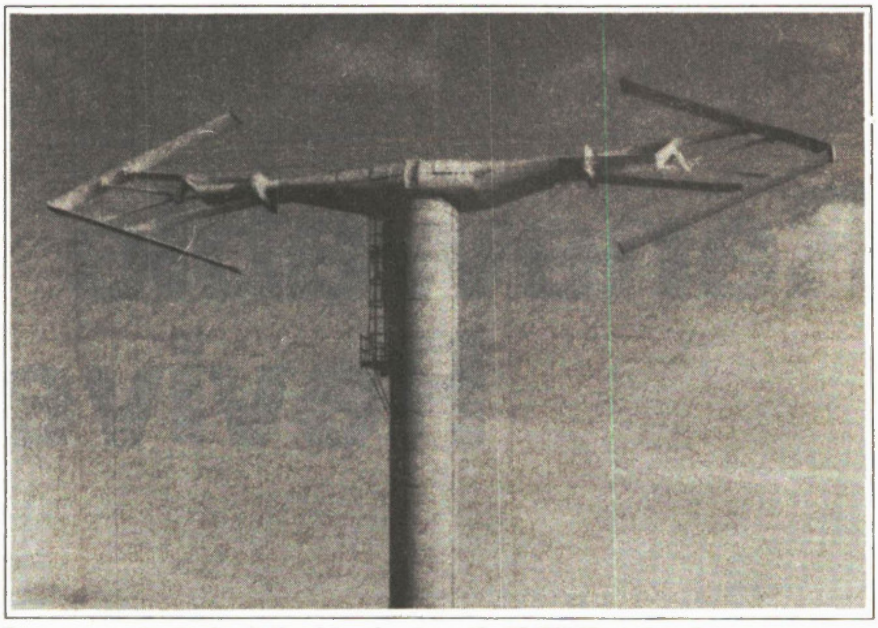
On the same site is a prototype advanced wind turbine, designed by students at Kingston Polytechnic, near London, and partly financed by the Balfour Beatty Ltd engineering and construction group, which it is hoped will prove more efficient than conventional turbines.

Although economically promising, the resource size may be limited by the availability of suitable sites. The answer is to have off- shore windfarms. A recent report showed this to be technically feasible, but with current technology, uneconomic.

Passive Power

Unlike wind energy, solar power is silent and pollution free, requiring few moving parts. The use of collectors to accumulate the sun's heat for water and space heating is known as the technique of active solar power.

By 1981 an industry had grown around active solar power, but most installations proved to be uneconomic so the government's solar programme is now focused on the passive version. The idea is to make maximum use of the sun's energy by, for example, building houses with a southerly orientation and masonry walls capable of storing heat during the day. The new town of Milton Keynes, near London, has various examples of passive solar power.



Prototype vertical axis wind turbine developed by VAWT Ltd., London.

Architects are also looking at passive solar systems for commercial buildings, hence the popularity of atriums (central courts) which allow maximum use of daylight as well as capturing the sun's heat.

Like the sun, the earth also radiates heat, and tapping this energy is the principle of geothermal power extraction. Beneath the earth's surface there are "hot rocks" and aquifers. Extracting heat from rocks is the subject of a substantial programme of research and development in the United Kingdom. The geothermal properties of granite are being investigated at a large scale test site in Cornwall, south-west England.

Unfortunately the few suitable sites that have been located so far in Britain are not near large population centres and it would not be economic to transport the heated water from a geothermal installation over any great distance on the surface.

Waste as Energy Source

Solar, wave, wind and tidal energy are the truly renewable resources. Geothermal energy can be considered in practical terms inexhaustible, and waste materials are plentiful and schemes extracting power from waste are gaining popularity throughout the world.

Britain alone dumps, burns or buries around 250 million tonnes of organic waste each year. Boilers are now being designed to burn anything from straw to tires and straw burning is particularly popular in rural communities. One of England's stately homes, Woburn Abbey in the midlands, recently installed a straw burning system which will heat water for the whole estate. It is estimated that savings of 21,000 pounds will be made each year.

Refuse that is buried in landfill sites gives off a gas which has half the heat value of natural gas and it can be used by industry or for electricity generation. A similar gas is also produced when micro organisms decompose wet waste in the absence of oxygen. The gas is 60% methane. Sewage treatment has incorporated this process for many years.

Between 1975 and 1985 Britain spent 84 million pounds on renewable energy research and although the government favours nuclear power, renewable energy is still seen as important for the future. It has even been described as an insurance policy. ■

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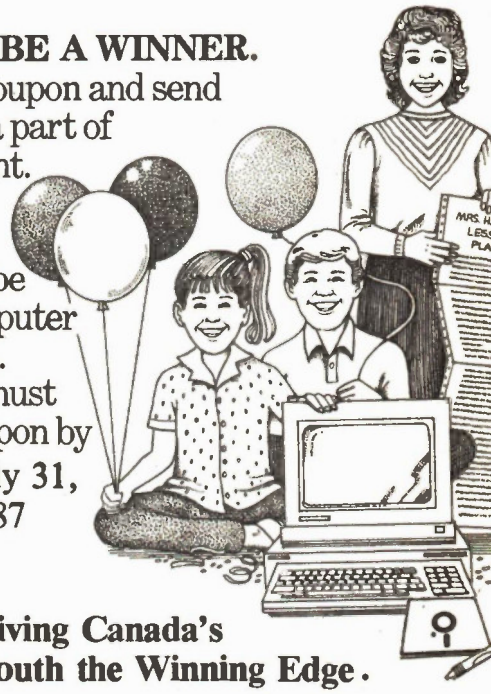

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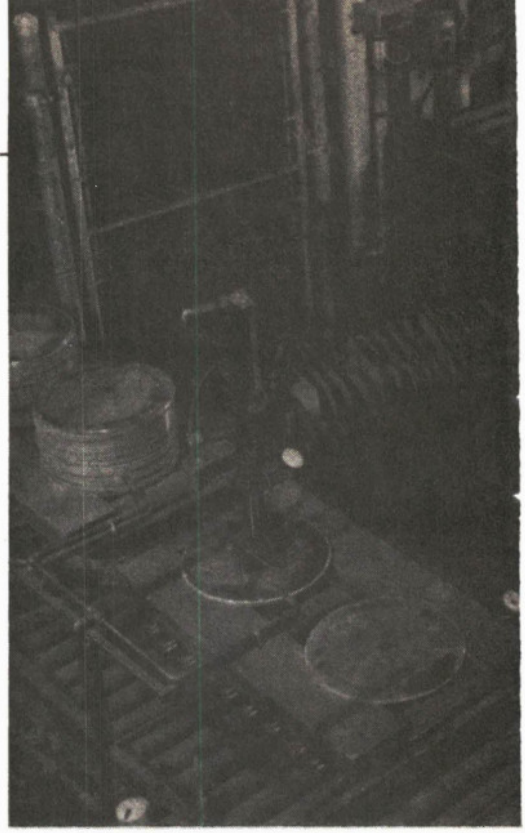
The Anatomy of a Robot



How the motors and the electronics work together to perform robot functions.

by Dr. H. Virani

When discussing robots, a number of technical terms need to be understood. They include the following:

End Effector: This is the focal point of description of robot motion. It could be a gripper, a tool, a welder, a waterjet cutter and so on. Robot motion is ultimately concerned with the motion of the end effector.

Position: This is the position of the end effector and generally consists of three locations and three angular coordinates. There can be more than one set of robot arm joint angles that will cause the end effector to be at some position.

Trajectory: This is a time sequence of end effector positions. The motion of the end effector as the robot runs a user's job is the end effector's trajectory.

Kinematic/Dynamic Trajectory: The kinematic trajectory is a theoretical or requested end effector motion. In practice the end effector follows a somewhat different path, the dynamic trajectory. The difference between the two is due to the cumulative effect of a number of disturbances including inaccurate machining, stiction, coulomb and viscous friction, uncompensated payloads, uncompensated gravity loads and finite mechanical stiffnesses. Clearly an important design consideration is to minimize the trajectory deviations due to the wide range of potential disturbances.

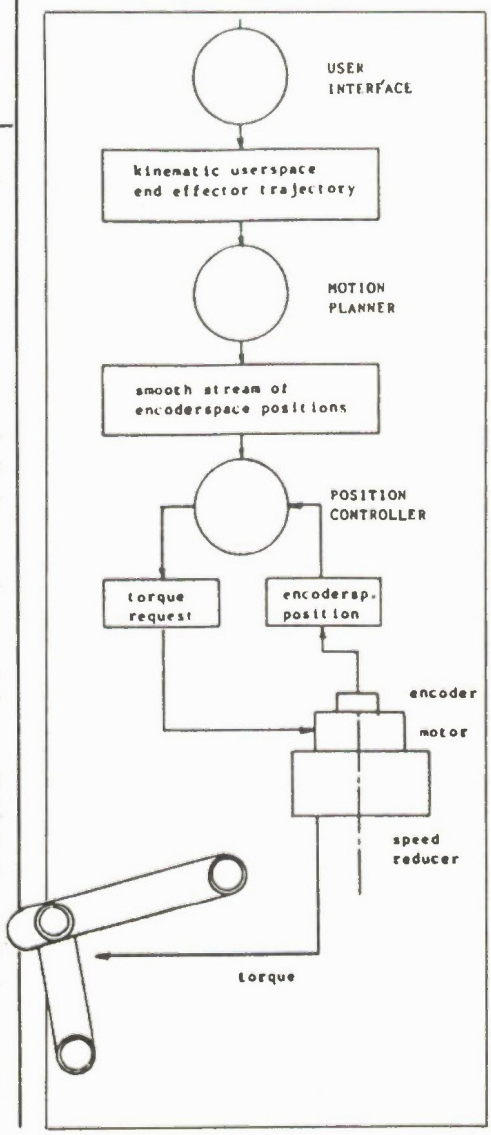
Userspace/Encoderspace: The user sees an end effector having a position in cartesian or may be cylindrical or spherical coordinates. A position described from the user's perspective is in userspace. Straight line motion by a five axis robot is an example of a userspace trajectory. The robot on the other hand "sees" a position as a set of joint angles. As joint angles are measured with encoders, positions described by joint angles are in encoder space.

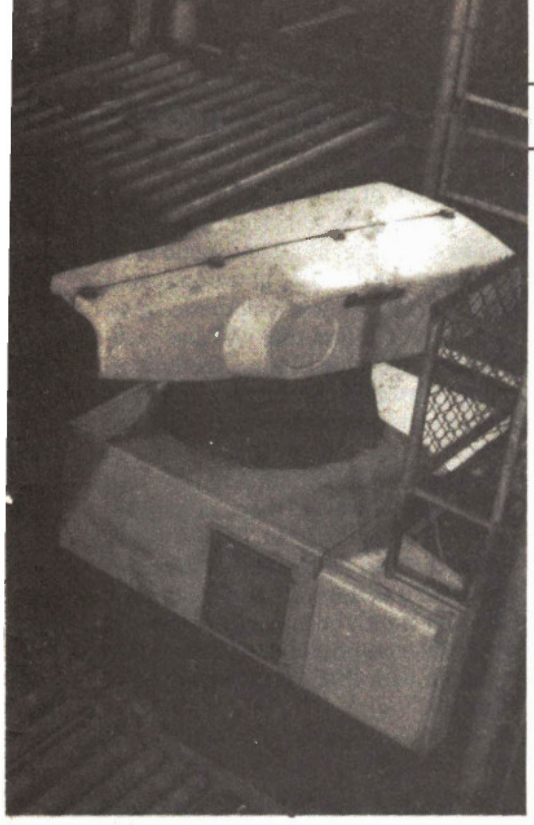
The two primary motion-related tasks of a robot are then to firstly enable the user to simple describe the desired kinematic end effector trajectory in userspace and secondly to move the end effector according to this description without too much deviation.

There are several main subassemblies that when combined enable the robot to undertake these tasks. They are:

- the mechanical components (links, bearings, speed reducers).
- the electro mechanicals (motors, encoders) that drive and sense the mechanicals.
- the position control module that causes the dynamic robot to be at any given encoder space position (or at least close to it) by driving the motors.
- the user interface that enables the user to construct the desired trajectory in the first place.

The relationship between the subassemblies is presented diagrammatically in Figure 1.





Mechanicals

The main mechanical considerations are those of strength, rigidity, lightness and accuracy. Also of concern is gravity compensation where possible. Robots are generally massively overdesigned from the point of view of maximum working load in order to withstand the intense shock loads that occur during collisions. They must be able to cope with full-speed worst-case impacts. As a consequence of this, other dynamic working load consideration such as fatigue and bearing life can usually be checked but ignored. Apart from lubrication and motor brushes it is very difficult to wear a robot out.

If the robot arm is not to vibrate when torque from the motors is applied, it must have a high stiffness; the higher the better. The least stiff components of robot drives are generally the speed reducers. Robots are home to what used to be relatively rare forms of these. For linear motions precision ground preloaded ball screws are used. For rotary motions harmonic drives or ballscrews and cranks are used. Both systems are expensive. There are movements at present towards various sorts of direct drive systems where the loads are light and the stiffness requirement can be relaxed somewhat.

Bearing systems also contribute to stiffness and robots usually have preloaded bearing arrangements. Great care must be taken with the design and machining of these if the bearings are not to be overloaded.

Expansion due to heating is particularly hazardous. While it is important that the arms should be stiff, they must also be light. Heat will inevitably be dumped by the motors into the bearing systems and there is no point in the motors heating up more than they need by accelerating unnecessarily heavy arms.

Positioning of mass in the arm is important as well. In order to diminish the heat load of the motor, gravity loads are compensated for where possible with arrangements of counterweights and springs. Whether the arm is fully extended or working in close to the base the only load the motors should support should be that of the payload.

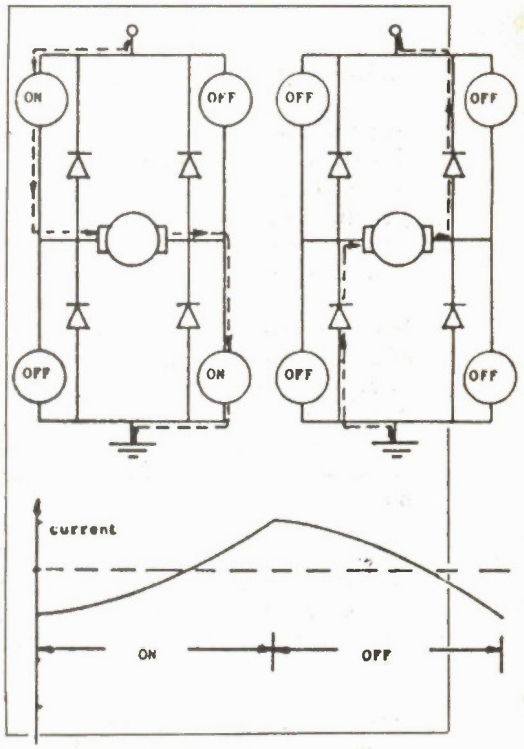
The Electromechanicals

The most common robot drive elements are electric motors, generally DC servo motors. Also used are hydraulic and pneumatic actuators. Hydraulics are used on large robots where DC servos would otherwise be too expensive, but are shunned on small machines. This is due to the extra size and cost of the hydraulic plumbing as well as the additional hydraulic problems.

DC servo motors linearly convert electric current into mechanical torque. There are two terminals on a motor. A particular current fed in at one terminal and taken out the other will produce a particular torque in one direction (e.g. clockwise). If the same current is fed through the motor in the opposite direction, the same torque will result but in the opposite direction (e.g. counterclockwise). Depending on the joint loading and inertia, a large current will produce a large torque and hence a large joint acceleration and a small current and a small acceleration.

The most common way of driving DC servo motors is through the use of an H-Bridge of switchable devices as can be seen in Figure 2.

When opposing top and bottom switches are turned on, current can flow through the motor in one direction. If the switches are then turned off current continues to flow in the same direction, due to the motor's inductance, through the free-wheeling diodes. Induction here acts very similarly to a flywheel in a mechanical



system. Clearly due to the symmetry of the arrangement, current can be pushed through the motor in both directions.

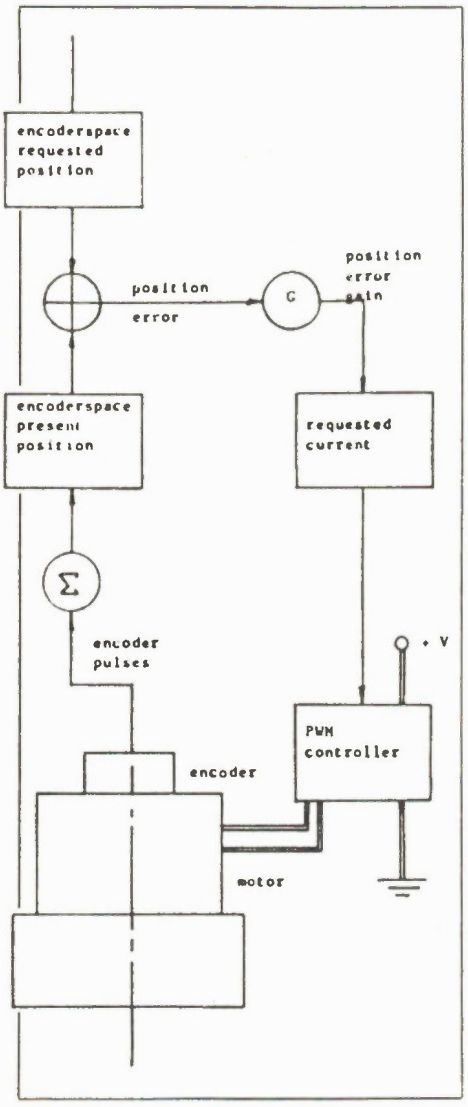
Sensing

To sense the moment by moment angular position of a joint, rotary optical encoders are generally used. Less common are resolvers and LVDT's. The encoders consist of a transparent disk with many fine radial lines inscribed on it. A light shines from behind the disk onto a light sensor. As a line passes between the light source and sensor a pulse in output from the encoder.

Encoders use two such sensors and are able to provide direction sense by outputting two square waves in quadrature. By counting how many up pulses and down pulses have been received since a reference position was passed, the robot is able to determine how far away it is from that reference position and hence determine its present joint angle in encoderspace.

Position Control

Feedback control loops are used to achieve position control of any particular joint. A simple scheme of two loops to control a DC servo is given here as shown in Figure 3. In a functional robot there are not likely to be less than three levels of loops.



Between 20 and 200 times a second, the position controller will receive a particular joint's requested position. The position controller knows the joint's actual position, as it has been counting encoder up and down pulses. If the joint position is lagging behind the requested position, then the position controller will ask for more current, hence more torque, to speed the joint up. The greater the disparity, the more torque is requested.

If the joint is actually ahead of its requested position, the controller will ask for torque (current) in the opposite direction to slow it down. What drives the position controller is not so much the requested joint position as the position error. At the lowest level, what is required by the position controller is the establishment of a particular value of torque. This demands that a particular voltage current be flowing. In robots DC servos are generally driven using pulse width modulation or PWM. The H-Bridge available to the PWM device can only be turned hard on or hard off. When the H-bridge is turned on, due to the flywheel-like effect of the motor inductance, the motor current gradually begins to increase. When turned off, the motor current gradually decreases. The motor current is sensed by the PWM control device.

The PWM Controller

The PWM controller basically works as follows. With the H-bridge on, the current rises to say 10% more than the desired value. The H-bridge is now shut off. The current now will gradually fall. When it declines to, say 10% below the desired value, the H-bridge is switched on again. If this switching is done very fast, then the average current and hence the average torque in the motor can be held to any desired value. A typical switching rate would be between five and forty thousand times a second.

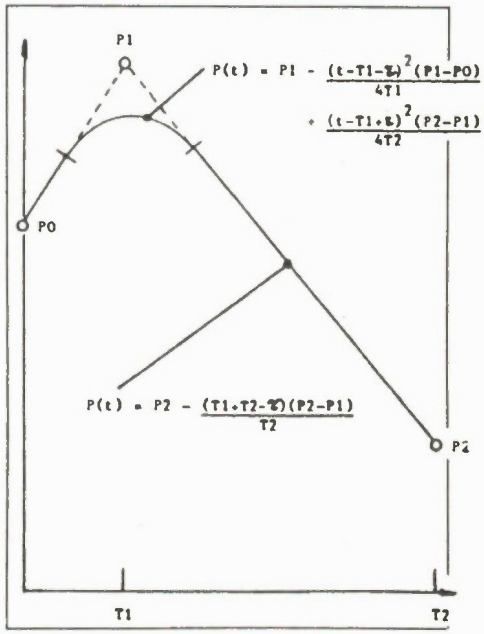
The position controller uses position error to attempt to cause acceleration or deceleration of the joint so as to reduce the error. Quite how much the controller reacts to an error of a given size is a function of the stiffness of the servo. A stiff servo will ask for a lot of torque to get rid of quite a small error.

To know how much torque to ask for, the position controller also needs to know the joint inertia. With a robot however the inertia is always changing, being as it is a function of the current configuration.3 Quite a number of disturbing torques can be compensated out at this stage, to a greater or lesser extent.

Motion Planner

The primary function of the motion planner is to take the user's description of the end effector trajectory and produce, 20 to 200 times a second, a set of instantaneous requested joint positions for the position controller. Before a set of instantaneous encoderspace positions can be supplied, a set of user space positions must be determined. These can then be transformed. The set of user space positions is found from the user's userspace trajectory description. This description generally takes the form of a list of positions together with the instructions to move in a straight line from position 1 to position 2 and again on to position 3 and so on, at a nominated speed. A set of linear kinematic equations can be found that will give position, for any value of time, the end effector position. At regular intervals these equations can be used to find the present requested position.

Due to the dynamic nature of a robot arm however, there is another layer of complexity in the problem. When the arm reaches on of the user-specified positions, it cannot instantly stop or instantly be moving in a straight line to the next nominated position. An example with three points is given in Figure 4.



Implementing this scheme is in practice quite a difficult problem. One of the basic tools at the disposal of the motion planner is the transform function that converts a user space position (position of the end effector in XYZ coordinates) to an encoderspace position (angle for each joint).
These transformation functions are commonly handled using homogeneous transforms. Homogeneous transforms combine translation and rotation in the one formulation. They are also commonly used in computer graphics and computer vision.

User Interface

While the user interface will generally be a large portion of the total amount of code in a robot, the proportion of it devoted to motion control is rather

small. The user interface must ascertain when the user is requesting an immediate motion for example "move the end effector up at 20% of full speed", and pass this information along to the motion planner. It must be able to ask the position controller for the present and effector position, so as to be able to save it as a point with a point number.

It must convert the instruction of a user job, for example "set speed 50%, go to point 1, go to point 2, stop", into codes that the motion planner will understand and then pass them along. It must be able to ask the motion planner to start or stop running one of these jobs at the user's request. In summary, the user interface provides the means whereby a user can straightforwardly define a potentially complex robot trajectory. The motion planner converts this trajectory description into a smooth stream of sets of instantaneous joint angles. The position controller uses a number of feedback control loops to request motor torques these moving the motors. Position feedback is derived from rotary optical encoders. The generated torque, via speed reducers, drives the assemblage of links and bearings that make up the robot arm. ■

Continued from page 7

For Your Information

Purpose of Wheels

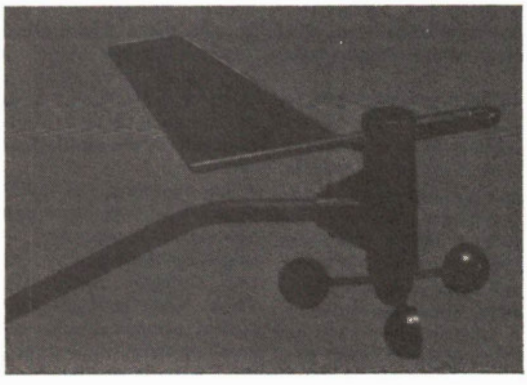
The blowing head itself is a pressurized metal chamber, housing two electrically driven wheels. Compressed air is fed into the head along with the optical fibre cable and the viscous drag of air carries the cable into the bore and through to its final destination.

The drive wheels are necessary only to overcome the pressure gradient from normal air pressure outside the head to 1.034 MPa inside. The wheels also help to draw the cable off the drum. Once the optical cable has entered the microducts, it is the viscous flow of air alone that propels it along.

The blown fibre system has a number of economic and technical advantages over conventional optical cable. Once a basic microduct network is in place, fibre cable can be installed gradually over a period of time as the need arises, thereby deferring fibre purchase cost.

It is not necessary to configure the whole microduct network right at the start. A basic route of microducts needs only to be laid initially into the vicinity of major customers. As service is requested, continuous point to point lengths of fibre cable can be blown in a short space of time, with no need for intermediate splicing. It is even possible to blow out fibre cables and replace them for network upgrading purposes. Finally, the microduct network can be extended, simply by adding branches at appropriate junction boxes positioned along the main route.

Personal Weather Station



PC Weather is a unique product which turns your IBM PC or compatible into a sophisticated weather monitoring and weather analysis system. The systems comes complete with its own anemometer and wind vane assembly, two temperature probes, a half-slot PC card, and display software.

Typical home uses include monitoring frost conditions in the garden, environmental control, and education. The unit is priced at $349.95US retail. Available options include a rain gauge and PC Weather Prol, an enhanced software package which provides expanded data display and analysis capabilities. Options are priced at $69.95US each. For more information contact: Technology Marketing Inc., 4000 Kruse Way Place, Building 2, Suite 120, Lake Oswego, Oregon 97035. (503) 635-3966.

Circle No. 67 on Reader Service Card

IBM scientists have overcome a major obstacle to the usefulness of the new high-temperature superconducting materials, showing that they can carry 100 times more electrical current than previously believed.

The IBM discovery shows that the new materials can sustain enough electrical current at liquid nitrogen temperature for most foreseeable applications, the IBM scientists say. Until this discovery, the potential usefulness of the new materials has been limited by their apparently small "critical current" capacity, the amount of electricity they could carry without losing their superconductivity. Superconductivity is the ability to pass electricity without resistance; it occurs only at very low temperatures. Superconductivity at the temperature of liquid nitrogen (77 degrees Kelvin, or 77 degrees above absolute zero) is the goal of researchers, because the temperature of other suitable coolants, such as liquid helium, is closer to zero and makes practical installations difficult.

Although other technical hurdles such as brittleness and possible incompatibility with other materials remain, the IBM scientists see this latest step as a key reason for increased optimism about the materials' future.

To measure the improved critical current, IBM researchers had to make the world's first thin-film single crystals of the new material. Substrates for the thin film had to be appropriately chosen and particular heat-treatment procedures were designed to produce the material's superconducting phase. IBM's thin-film single crystals are approximately one micron thick (about one one-hundredth the thickness of a human hair) and about one inch in diameter. At 77 degrees K the critical current was measured to be in excess of 100,000 amperes per square centimetre. This is 100 times more electrical current than previously measured.

By demonstrating that an increased amount of current can flow in the new materials, the scientists have more widely opened the door to applications such as electronic devices, circuits and computer-chip interconnections, power transmission lines, electric motors and electromagnets.

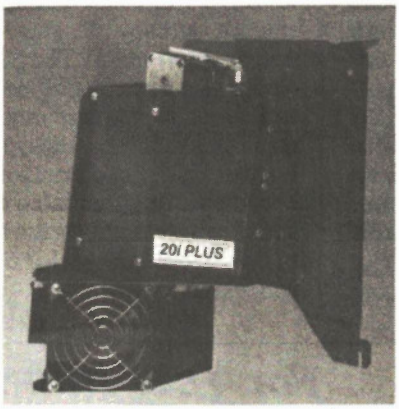
In related developments, other research teams at the IBM Thomas J. Watson Research Center have produced bulk single crystals in two varieties: some with widths of several millimetres and others as thick as 200 microns. The thicker crystals show that superconducting current flows 30 times better in one direction than in another. Knowing of this direction-dependent property, called anisotropy, could help scientists facilitate development of applications for the new materials.

These are the latest developments in a series of events that began last April when K. Alex Mueller and J. Georg Bednorz at IBM's Zurich Laboratory discovered superconductivity in a new class of oxides. Since then, IBM researchers have made the first high-temperature super-conducting thin films, the world's first practical electronic device with the new materials, and have also developed a way to coat large and complex shapes with the superconducting materials.

AimTest Ltd of the United Kingdom, has appointed Duncan Instruments Canada Ltd. as their Canadian representative. AimTest manufactures Digital DataBridges for measuring L, C, R, Q and D values in L, C, and R components. In addition, AimTest also manufactures a Digital Low Distortion Oscillator. Contact: F. Bruce Petty, Duncan Instruments Canada Ltd., 121 Milvan Drive, Toronto, Ontario M9L 1Z8. (416) 742-4448.

Circle No. 68 on Reader Service Card

New Internal Mac Hard Drives



Rodime Inc. has introduced two new internal hard disk systems for the Apple Macintosh: the 20i Plus and the 45i Plus.

Both the 20i Plus, which features 20 MBytes of storage, and the 45i Plus, with 45 MBytes of storage, are contained completely within the Mac's housing and are fully shock-mounted.

The rugged installation makes them the ideal choice for any Macintosh which must be moved from place to place. Both units also feature built-in fans which cool both the drive and computer.

The drives are connected to the Mac's SCSI port and take advantage of Rodime's advanced drive interface delivering access speeds of up to 10 times faster than the Mac's floppy drive.

For more information contact: Jack Brown, McKenzie Brown Canada Inc., 267 Richmond Street West, Toronto, Ontario M5V 1W9. (416) 593-6880 or 1-800-387-9016

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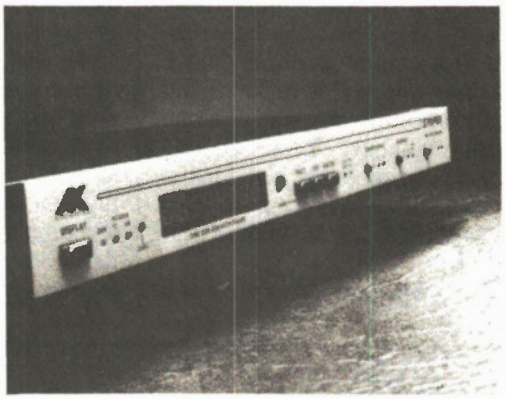
Timecode Generator



For recording studios, a multistandard timecode generator and reader is available from Britain. Apart from the normal facilities of reading timecode or user bits, the Striper unit can be used to record timecode on audio machines at high speed. The code outputs can be set to 1x, 2x, or 4x, play speed, so if the tape machine's speed is switched up, code can be striped in half or even a quarter of the time. It can be used with the 24, 25, or 30 frame/sec and drop-frame standards.

Capable of reading both timecode and user bits (permitting new code to be generated from bad code) the generator can be locked to internal crystal, video synchronizers or the frame rate output of the company's Gearbox unit. It is also compatible with the revised EBU/SMPTE format with the included parity bit.

For more information contact: Allan Nichols, J-Mar Electronics Ltd., 6 Banigan Drive., Toronto, Ontario M4H 1E9. (416) 421-9080 or Telex 06-986766.

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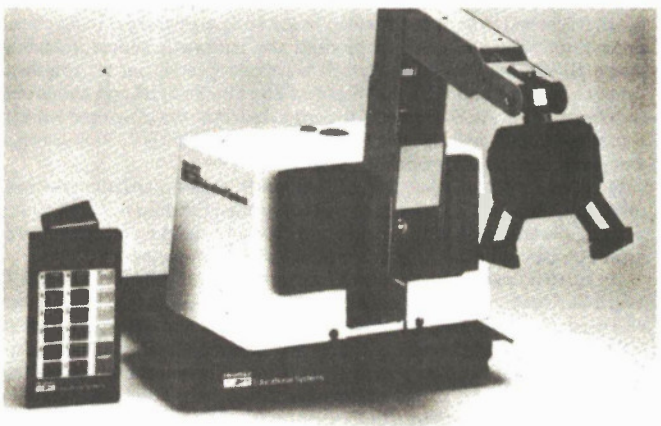
Robot Arm Trainer



The Heath Company of Toronto has introduced a cost-effective robotics training system to teach students fundamentals of industrial robotics. Robot Arm Trainer is simple to understand and operate, designed specially for the classroom and training centre.

Features of the Heathkit/Zenith Robot Arm Trainer include: five axes of motion, on-board 8-bit CPU, six closed loop DC servomotors, sense-of-touch gripper, industrial-type teaching pendant and many others.

A complete series of courseware for the Robot Arm Trainer offers a mix of robotics theory and hands-on experience and is available in both classroom and self-study format. The classroom version includes an instructor's manual, robotics textbook (2 volumes), student workbook and materials for experiments. The price: $4195, available from Heath/Zenith Computers and Electronics retail outlets across Canada.

Circle No. 71 on Reader Service Card

New Explorer

The Germantown, Md., division of Fairchild Industries, Inc., has been selected by NASA's Goddard Space Flight Center as the prime contractor for the Explorer platform program. The Explorer platform, which will be launched in 1991, will initially carry an instrument payload for studying such celestial mysteries as hot white dwarfs, pulsars (collapsed stars) and black holes, all of which emit extreme ultraviolet radiation.

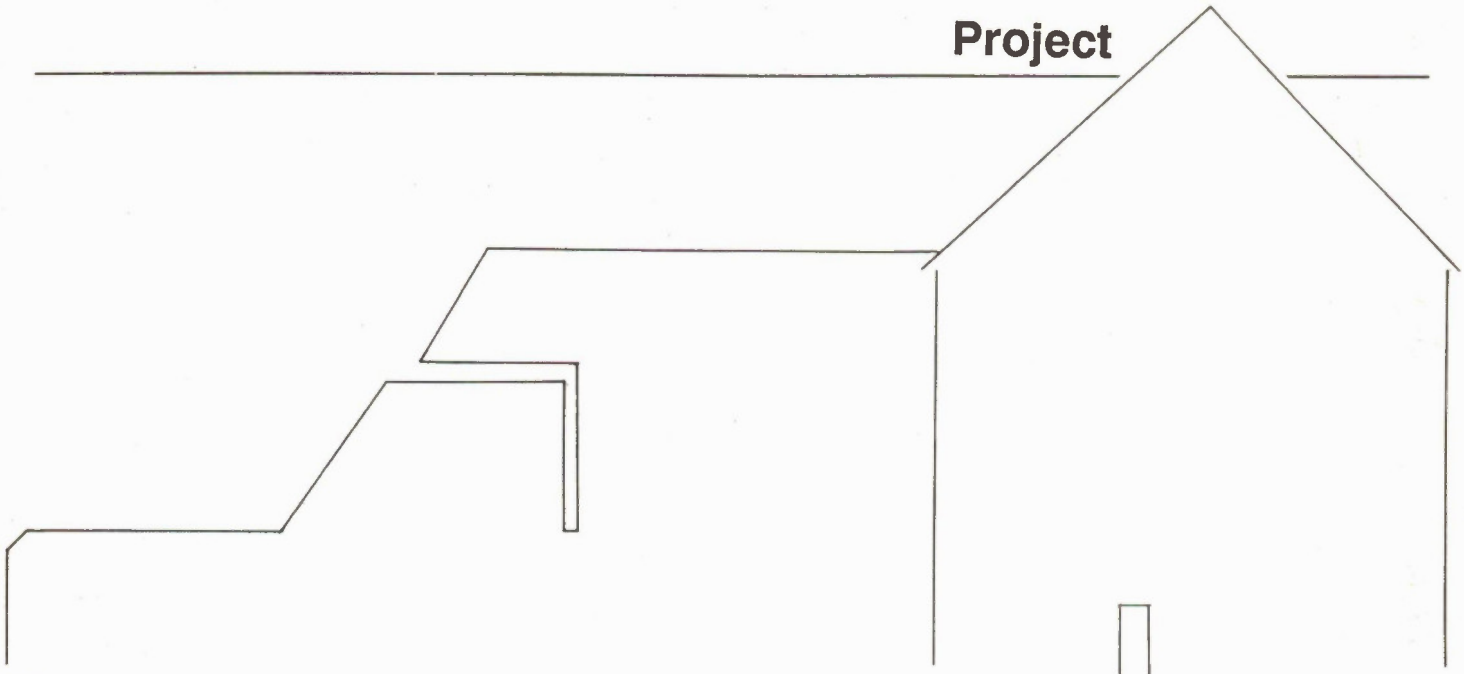
The instrument package called Extreme UltraViolet Experiment (EUVE) will consist of four telescopes designed to operate in this little-explored spectral region. While the vast majority of stars seen from the earth have temperatures less than 18,000 degrees Fahrenheit, EUVE will observe objects 5 to 10 times hotter. Some will be young stars, but most will be in the last stages of existence. They will have burned, or nearly burned, all of their nuclear fuel and will be in the process of collapsing in upon themselves. Among these doomed stars are white dwarfs, which can be as hot as 180,000 degrees, but are small and faint. Several dwarfs have been detected by sounding rocket and satellite instrumentation.

EUVE is also expected to observe coronas, the million degree atmospheres surrounding some stars; binary (paired) stars that transfer material between themselves; and quasars, those distant galaxies with immense energy output. Perhaps the most abundant objects, however, are defunct pulsars, or neutron stars, that are essentially unnoticable in the visible part of the spectrum.

A key component of the Explorer platform will be the multimission modular spacecraft (MMS), originally developed by NASA and the Fairchild Space Company. Three MMS modules will supply power, communications and data handling and attitude control to the satellite and permit repair and maintenance of the spacecraft on orbit.

Fueled by the yen's sharp rise in value and the rapid declines in crude oil prices, Japan's imports of manufactured goods in 1986 chalked up a steep 31.4 per cent increase over the previous year despite a 2.4 per cent drop in total imports, according to the Japan External Trade Organization (JETRO).

Hobbilt Electronics of Quebec would like to announce the addition of a new store located in Montreal. The address is 3117A Hochelaga, Montreal, Quebec H1W 1G3. Tele. (514) 522-1432. Hobbilt is also located at 7454 Langelier, St. Leonard, Quebec H1S 3B7. Tele. (514) 259-5581. **Circle No. 72 on Reader Service Card**



Refrigerator Alarm

Designed for RVs but equally suitable for household use.

By T.R. de Vaux-Balbirnie

Most recreational vehicles are fitted with a refrigerator. This uses a gas flame or electric element to heat the refrigerant contained in a small boiler to the rear of the food cabinet. Interruption of the supply, for whatever reason, will soon result in ruined food, especially in warm weather.

This project is a self-contained alarm of very small physical size and near-zero power consumption. Placed inside the refrigerator, it emits a loud tone if the internal temperature rises above a preset level.

When used in a trailer the sound cannot, of course, be heard while driving so the device is limited to on-site operation. In a self-contained RV, however, it may be heard from the driver's seat, although not, perhaps, with the engine running. The alarm is equally suitable for household use and is especially useful where children leave the door open.

The prototype unit has been shown to be loud enough for all normal purposes but there could be times when it is insufficient; under noisy conditions, for example. In case of doubt, obtain the buzzer only (make sure it is the high intensity type as specified) and by connecting this directly to a 9V battery inside the fridge, the value or loudness of the device may be assessed.

Standby current consumption of the alarm is less than 5uA so the internal battery will give excellent service. Consumption rises to approximately 35mA with the alarm sounding. The on-off switch provides a test facility whereby the battery may be checked periodically. The small size of the unit ensures that very little food space is lost - this is especially important with one cubic foot fridges.

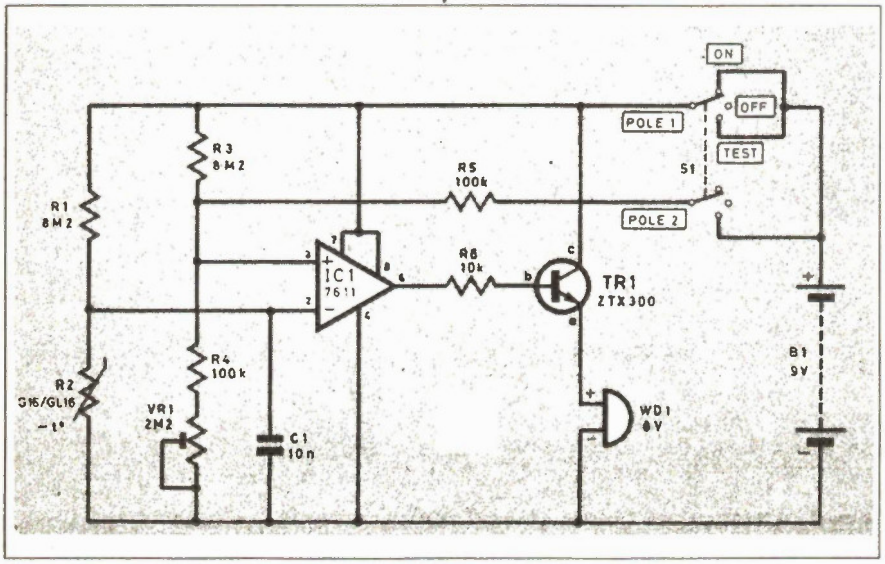


Fig. 1. Complete circuit diagram for the Refrigerator Alarm.

Circuit

The circuit for the Fridge Alarm is shown in Fig. 1. IC1 is an operational amplifier of a type chosen for its extremely small current requirement. R2 is a negative temperature coefficient thermistor which, together with R1, forms a potential divider connected across the supply. Thus, a certain voltage exists at the op-amp inverting input (pin two). This voltage falls as the temperature of R2 rises.

A second potential divider consisting of R3 in the upper section in conjunction with R4 and VR1 in the lower one is connected to the op-amp non-inverting input (pin three). With VR1 correctly adjusted and with R2 below the required operating temperature, the voltage at the inverting input will exceed that at the non-inverting one. The op-amp is then off with pin six low (battery negative voltage) and having no further effect. With R2 sensing a higher temperature, the voltage at the inverting input falls below that at the non-inverting one and the op-amp switches on with pin six high (battery positive voltage). This operates TR1 hence the buzzer, WD1, in the emitter circuit.

Switch S1 is a three-position four-pole type. In this application only two poles are used. Pole one directs current to the circuit when the switch is set to either of the extreme positions (Test and On) - the centre position is Off. Battery checking is provided by Pole 2. When S1 is in the Test position, R5 makes IC1 pin three go high so operating WD1 irrespective of the temperature of R2. Note that very high value resistors are used in the potential dividers to reduce the continuous current drain whenever the circuit is switched on.

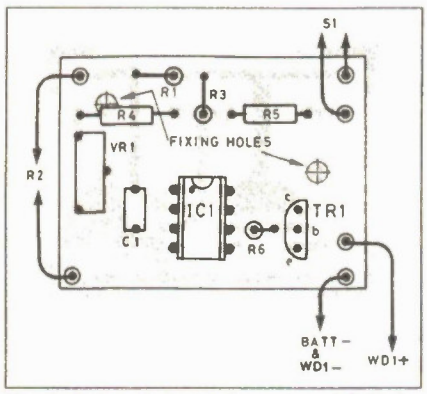
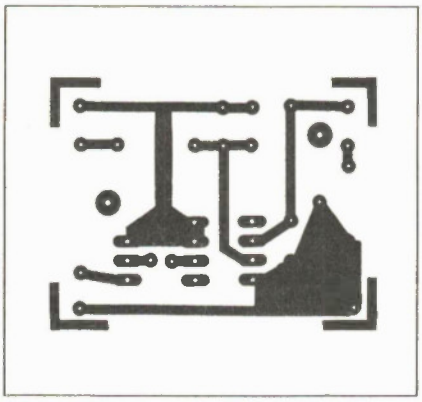


Fig. 2. Printed circuit layout and full size pattern (right).



Construction

Warning: since IC1 is a C-MOS device and therefore vulnerable to static damage, do not unpack it until it is required. When inserting it into its holder, do not touch the pins.

The prototype was constructed in an aluminum case but a plastic one of similar size would serve just as well. The circuit is based on a printed circuit panel size 40 x 27 mm. The master pattern to be etched is shown full size in Fig. 2. The component layout is also shown in Fig. 2.

Mount the on-board components. Using light-duty stranded connecting wire, extend R2 connecting wires by 5cm and sleeve them using pieces of insulation removed from connecting wire. Solder 5cm pieces of stranded connecting wire to the points indicated on the PCB. Drill countersunk holes in the base of the case for circuit panel mounting and make the holes for WD1 and S1.

Note the manner in which WD1 is mounted; this is neater than direct surface mounting. Measure the position of VR1 and drill a hole in the case so that this component may be adjusted with the lid in position using a small screwdriver. Drill a small hole near R2's position and fit it with a rubber grommet. Mount the buzzer and switch and complete all wiring (see Fig. 3). WD1 is polarity-sensitive and

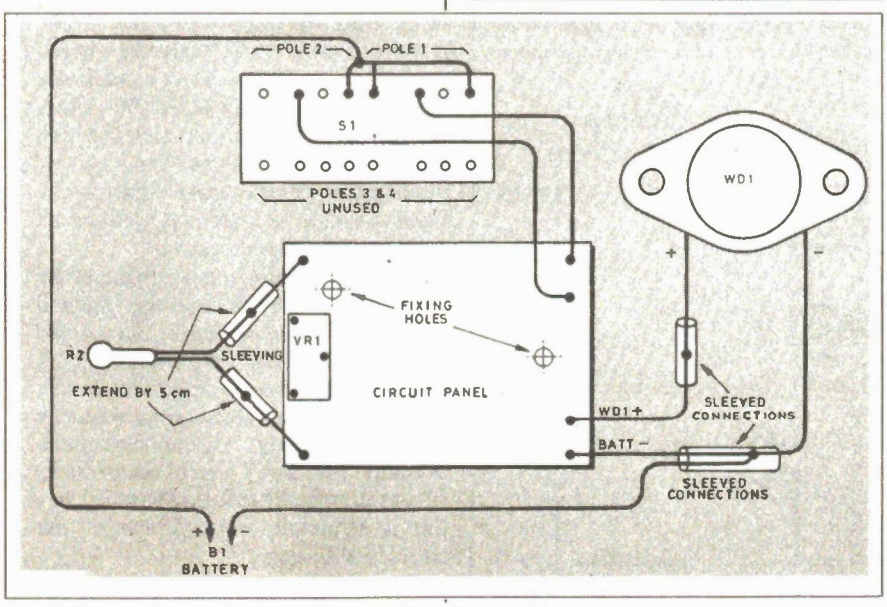


Fig. 3. Interwiring to the thermistor (R2), switch and buzzer.

Parts List

Resistors

All 0.25W +/- 5% except where noted

R1,R3 ..... 8M2
R2 1 meg negative coefficient bead thermistor
R4,R5 ..... 100k
R6 ..... 10k

Potentiometer

VR1 2M2 stand. preset, vert. mount.ing

Capacitor

C1 ..... 10nF

Semiconductors

IC1 ..ICL7611CMOS op amp
TR1 ..... 2N4401

Miscellaneous

B1 9V battery and connector
S1 mini. 4-pole, 3-pos. slide sw.
WD1 6-9V buzzer, Active #76090

Case to suit; stranded connecting wire; rubber grommet; 8-pin DIL socket.
1 meg bead thermistors are available from ElectroSonic, Willowdale Ontario.

will not work if connected the wrong way around.

Attach the circuit panel to the base of the box using small countersunk screws through the holes drilled for the purpose. If a metal case is used, prevent short-circuits from occurring between the copper tracks on the underside of the PCB. and the metalwork by using small standoff insulators. Alternatively, place a thick piece of cardboard between the base of the case and the circuit panel.

Testing

Switch S1 off (centre position) and rotate the VR1 sliding contact fully clockwise. Connect the battery and place in position; this is self-wedging if the specified case is used. Switch S1 to Test and check that the buzzer sounds. Switch to On, the buzzer should sound, and adjust VR1 to silence it. Warm R2 between the fingers whereupon the buzzer should sound again. If this basic operational test reveals that all is well, place the lid into position and gently coax R2 so that the body protrudes through the rubber grommet. Secure the lid and check that VR1 can be adjusted through the hole in the case using a small srewdriver.

Often the best place for the unit is attached to the inside of the fridge door. Heavy-duty double-sided adhesive tape may be used to secure it. The door will then act as a sounding board and give loudest results. It also leads to a fast response time if the door is left open.

Using the Alarm

With the unit in position, allow the fridge to reach operating temperature before switching on. If the fridge is already at operating temperature, allow half an hour at least before making adjustments. VR1 should be adjusted quickly (before the temperature rises unduly) so that the buzzer just ...gains off. This adjustment is critical ...should be made over a trial period. ...ck that the buzzer sounds when the ... is left open. The unit may now be ...tten except to check the battery ...few months. If ever the alarm ...for a long time, it is advisable to re... the battery and this should be done, as a matter of routine, before each season's use. ■

Aircraft Vision Systems

Flying today's hi-tech aircraft requires more than perfect 20-20 vision.

By Robert Butcher

The ability to fight through an effective 24-day must have been the dream wish of every military commander from Alexander the Great to the western front generals of World War I.

For the tacticians of air warfare, this capability is even more vital, since the environment in which they operate can be as hostile as the enemy himself.

Over the past few years in Britain, a team from the Combat Mission Systems Division of the Royal Aircraft Establishment (RAE) flight systems department at Farnborough, southern England, along with pilots of the experimental flight department, has been developing electro-optic sensors for ground attack aircraft on high-speed, low-level missions. The equipment is dedicated to enhancing target acquisition and aiming, and is an aid to flying at night or in poor visibility.

It meets a Royal Air Force (RAF) requirement for a system providing high speed, low level day and night attacks on ground targets.

Undetectable System

The RAE's Nightbird program has shown that a relatively low-cost, passive system, enabling a fast ground attack aircraft to be flown at night or in poor visibility by the same techniques as those employed during daylight, can meet this requirement. Moreover, it could increase the operational effectiveness of the aircraft by as much as 40 per cent.

A tactical advantage of the system is that, being passive, it is undetectable. A terrain following radar (TFR) like that fitted to the RAF Tornado, is an active system and therefore detectable, which makes it unsuitable for many of the roles undertaken by a ground attack aircraft.

Initially, the team examined three technologies: low-light television (LLTV), night vision goggles (NVG) and forward looking infrared (FLIR) systems.

Trials were carried out with an LLTV camera mounted in an aircraft's nose. The camera was light-limited, and operated in the visible and near infrared wavebands. The image was presented to the pilot on a head-up display (HUD) with 1:1 magnification, deployed to be superimposed on, and corresponding with, the view of the outside world. Normal HUD symbology for flight information - height, speed, directional setting, and so on - was overlaid on the image.

Limited Scope

Flying became possible in light levels down to 1/4 moon, but as the field-of-view window was only some 20 degrees, it could only be effective over benign countryside and when gentle manoeuvres were made.

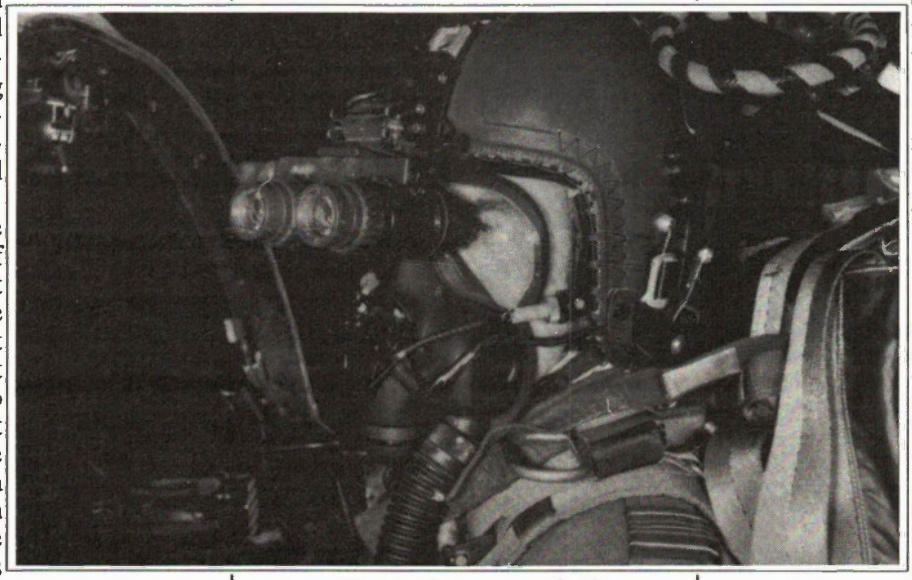
Night vision goggles (NVG) became available in the early 1980s, and, although similar to LLTVs in their method of operation, they are worn instead as a pair of lightweight binoculars fitted to the pilot's helmet allowing him to look directly through them. The advantage to NVGs is that they require no aircraft installation.

The equipment used in the Night program had a 40 degree field of view centered on the pilot's eyes, and by turning his head he could see in any direction. If NVGs are used, cockpit lighting must be confined to the blue-green end of the spectrum to which NVGs are insensitive, otherwise they would be dazzled. Instruments are viewed by the pilot, looking down below the goggles, which stand away from the eyes.

In Starlight

NVGs are sensitive to the red and near infrared wavebands, that part of the spectrum from which most starlight and moonlight energy emanates, and where the reflectivity of earth and vegetation is good. In fact the equipment can operate down to starlight conditions.

Results from NVG trials showed that they could provide a good night flying capability and the fact that the pilot could move his head and look around was a significant advantage in manoeuvring. In addition, if the equipment did not weigh more than 650 to 700 grams, it could be accommodated without undue discomfort, including the effect of "G" forces for the duration of a normal mission.



But the availability of NVGs in the target acquisition mode was limited to that of the naked eye; it was not possible to see through, as it were, the camouflage of a small target such a tank. Like the LLTV, the NVGs on their own failed to meet the requirement.

Unlike the other two technologies, the third option was not light-limited. This was the infrared sensor fitted to the nose of a Hunter T7 trainer aircraft for flight trials. In this case, the image is displayed in the same way as the LLTV installation and is also matched to the 20 degrees of the HUD field of view, with the same superimposition of flight symbology.

Clear Images

Being in the visible wavebands, the LLTV operates at about 0.4 to 0.9 micro meters, whereas the forward looking infrared installation works in the 8 to 14 micro meter waveband. It therefore detects energy radiated from what it sees, rather than light reflected from specific objects, as with the LLTV. The images produced are excellent, and interpretation has proved as easy as for the LLTV.

To achieve optimum image quality during the trials, constant fine tuning of the FLIR's temperature, offset and sensitivity controls was required. To reduce pilot work load, a system of automatic controls was developed. This compensates for wide variations in scene temperature, and provides detail in the ground scene, even though the proportion of sky to ground in the field of view can vary widely during aircraft manoeuvring.

FLIR operates in total darkness and can penetrate industrial haze and mist, although ti is limited by thick fog and rain. Objects with a high infrared signature, like tanks, are easily discernible by infrared sensors, and are difficult to camouflage in the thermal band. The trials demonstrated that most navigational features show up well: rivers, roads, lakes, buildings and trees are clearly visible. Yet, with the LLTV, the limitations on manoeuvring still remained.

Double Capability

None of the technologies separately met the requirements; the answer lay in a combination of FLIR and NVG. By adopting this technique, the pilot can use NVG to provide wide manoeuvring capability when flying under cloud or in little or no moonlight, while FLIR gives him good forward penetration through mist and haze. FLIR also presents him with the explicit targeting information he needs to complete the mission.

This principle of combination has proved so successful in practice that the RAF has contracted GEC Avionics for a system to equip the Tornado and Harrier GR MK 5 aircraft. The United States Marine Corps Harrier AV-8Bs will be similarly equipped.

The team is now considering ways of expanding an aircraft's mission capability still further. An aircraft of the future will carry, in digital form, a terrain description of the area over which it is flying. Extremely accurate navigation is possible by comparing the outputs of on-board sensors with this digital database.

Given the terrain database and an accurate aircraft position, a perspective view of the scene ahead of the aircraft can be generated in much the same way as a computer generates images for simulators.

Essential Information

Moreover, a simplified display without excessive clutter, showing ridge lines and major obstructions overlaid on the FLIR image, could convey essential information necessary for safer low flying without TFR at night or in poor visibility. Other information, target zones, hazardous areas and so on could be fed into the display as part of a mission planning system.

One of the RAE's Hunters is now being equipped to provide a flight tool for research into these techniques. A Buccaneer is also to be used for further development of electro-optic sensors, and the integration of these and other sub-systems using a digital databus.

Robert Butcher is a former press officer with Rolls-Royce Ltd. of Bristol, South-west England. ■

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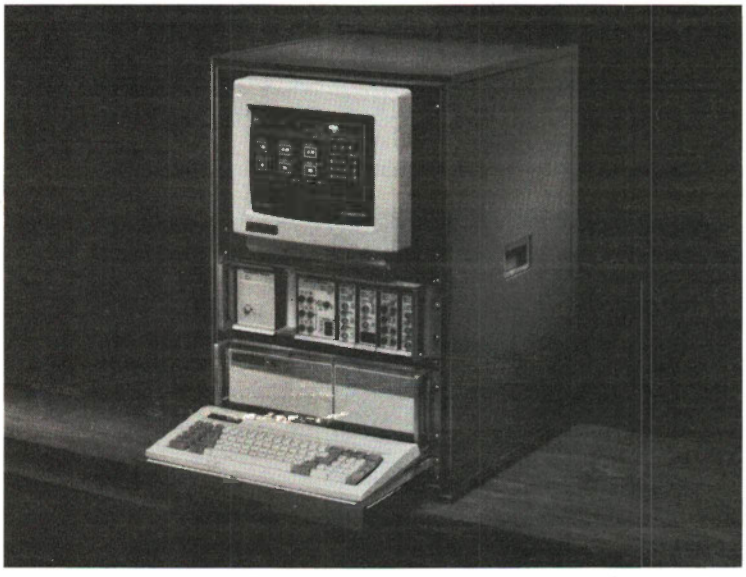

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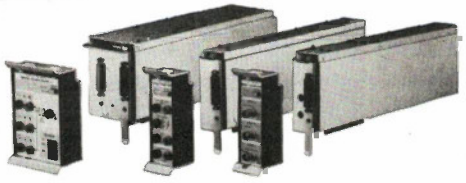

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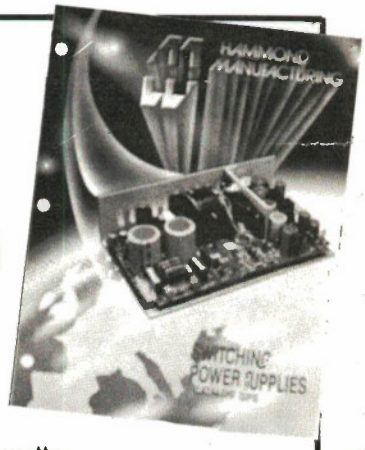

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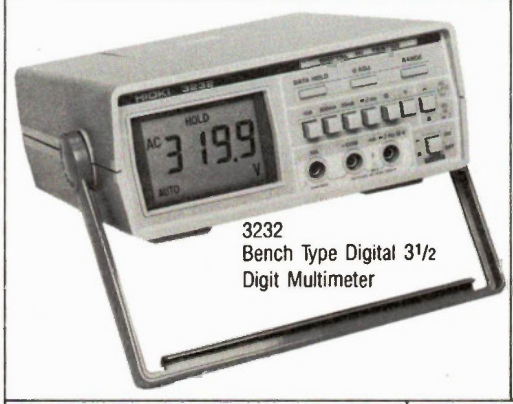

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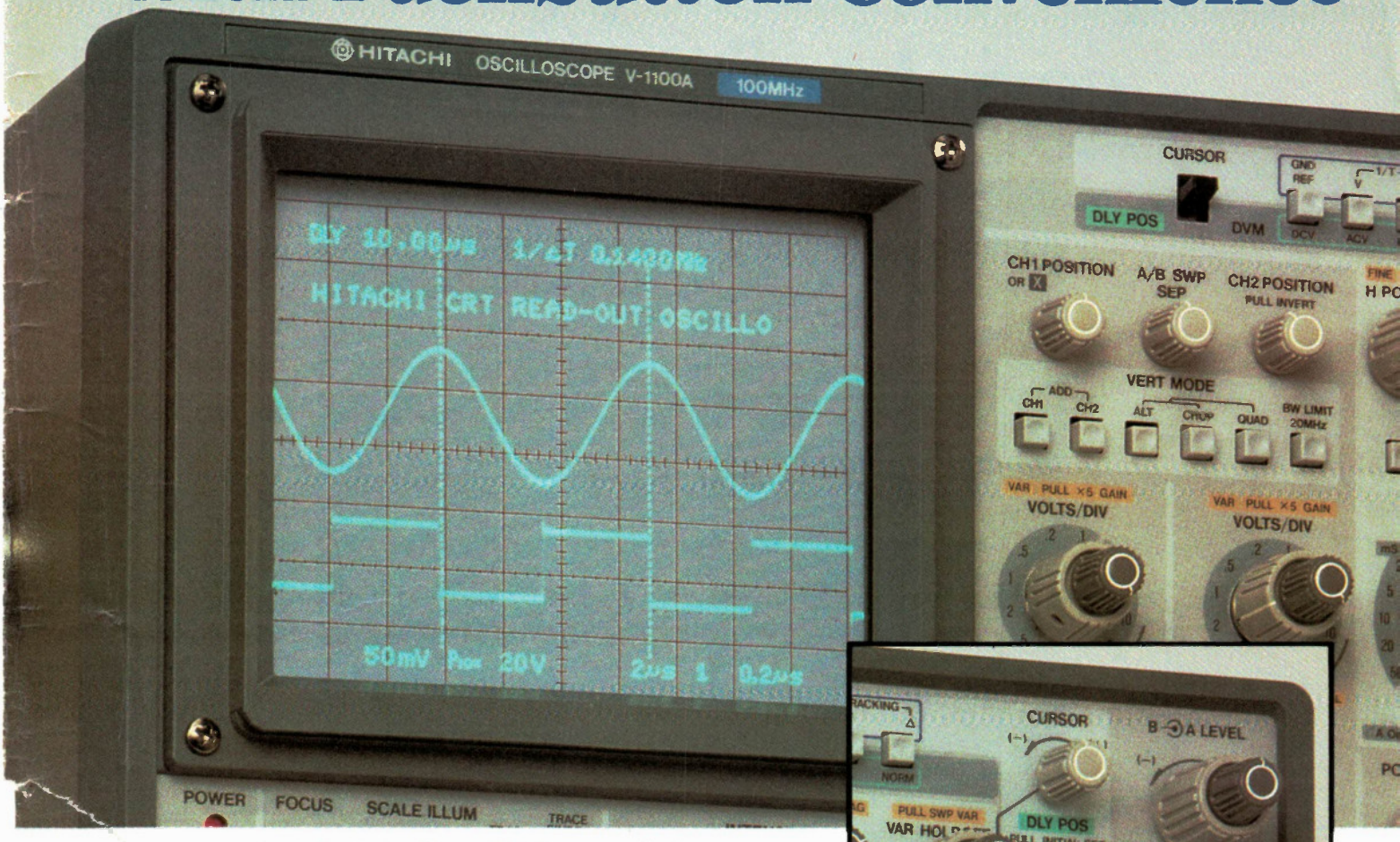

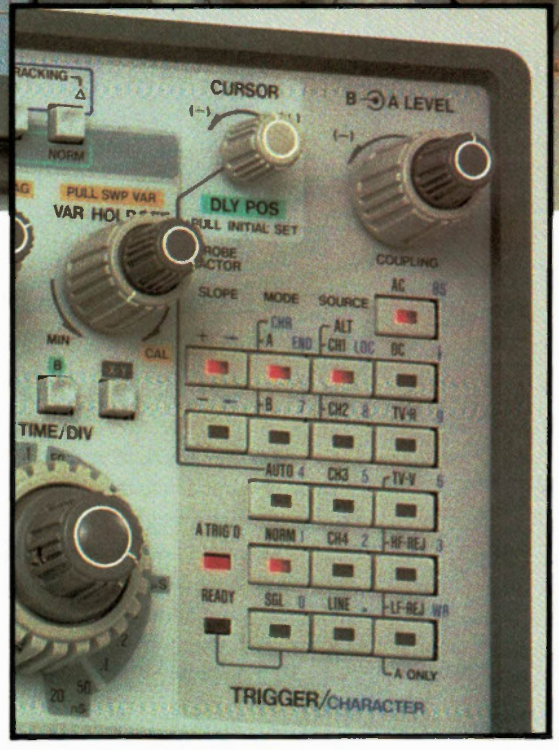

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